Spoken Dialogue Strategy Focusing on Asymmetric Communication with Android Robots

Daisuke Kawakubo¹, Hitoshi Ishii¹, Riku Okazawa¹, Shunta Nishizawa¹, Haruki Hatakeyama¹
Hiroaki Sugiyama², Masaki Shuzo¹ and Eisaku Maeda¹

Abstract—Humans are easily conscious of small differences in an android robot’s (AR’s) behaviors and utterances, resulting in treating the AR as not-human, while ARs treat us as humans. Thus, there exists asymmetric communication between ARs and humans. In our system at Dialogue Robot Competition 2022, this asymmetry was a considerable research target in our dialogue strategy. For example, tricky phrases such as questions related to personal matters and forceful requests for agreement were experimentally used in AR’s utterances. We assumed that these AR phrases would have a reasonable chance of success, although humans would likely hesitate to use the phrases. Additionally, during a five-minute dialogue, our AR’s character, such as its voice tones and sentence expressions, changed from mechanical to human-like type in order to pretend to tailor to customers. The characteristics of the AR developed by our team, DSML-TDU, are introduced in this paper.

I. INTRODUCTION

In addition to a human-like appearance, smooth movements, and rich facial expressions, the intelligence of android robots (ARs) is being improved so as to become closer to the human level in spoken dialogues. AR systems developed by Ishiguro et al., such as the Geminoid [1] and ERICA [2], were made available to us participants in the Dialogue Robot Competition (DRC). The scope of the competition was to evaluate an AR’s practicality in real situations. For the task of sightseeing-spot recommendation at a travel agency, participants tried to develop an original multimodal dialogue system using Android I, an ERICA-based platform (Fig. 1). For the 2022 competition [3], our team, DSML-TDU, which had joined in the first competition in 2020 [4], updated the system, focusing on asymmetric communication [5] as explained below.

Humans are easily conscious of small differences in an AR’s behaviors and utterances. Therefore, we tend to treat ARs nowadays as not-human, although our developed ARs treat us as humans. This asymmetricity can be seen when we communicate with an AR.

We should try to develop dialogue strategies in consideration of this asymmetric communication between robots and humans, as Bono [6] also said “we can only develop conversations between robots and humans on the basis of the ‘differences’ that humans unconsciously recognize as species.” We assumed that ARs would have acceptable communication styles which real humans would probably avoid using. In the case of communicating with someone for the first time, for example, humans will talk starting with casual topics and avoid personal matters. Here, we have a question whether we can allow the AR’s impoliteness or lacking consideration. As a discussion of this asymmetric communication, our team’s system and competition results at DRC 2022 are described in this paper.

II. OUR TASKS IN DRC 2022

The preliminary round of DRC 2022 was held at the mock travel agency booth in Miraikan. The detail of the competition are shown in the overview paper [3]. Android I acts as a salesperson at a travel agency and communicate with a customer. A customer as an experimental participant who has two alternative spots selected previously by him/herself decides one through a 5-minute dialogue with Android I. In this situation, our challenging tasks are to give a customer enough information for both spots, to make him/her feel enjoyable through the dialogue, and to lead his/her decision to the recommended spot randomly designated by organizers.

III. DIALOGUE STRATEGY FOCUSING ON ASYMMETRIC COMMUNICATION

The dialogue of the proposed system consisted of 7 phases (Fig. 2). Our system consists of a dialogue transition control system, a fashion item detection module, a chit-chat dialogue generation module, a knowledge selection module, and an answer generation module (Fig. 3).
ARs have a human-like appearance, so their behaviors that deviate greatly from humans can cause customers to feel uncomfortable. This is important in focusing on asymmetric communication. We used tricky phrases in the proposed system. If these phrases were used by a human, the customer would feel uncomfortable, but if they are used by an AR, the customer could see them as acceptable and have a good impression.

A. Shortening Psychological Distance from Customer

At the beginning of dialogue, the customer expects the AR to make utterances and has an attitude to listen. Therefore, from the beginning, the AR uses the customer’s fashion item to say, “Your glasses are very nice.” If a human made this utterance in a first meeting with a customer, the customer would feel uncomfortable as this would be too personal, but if an AR makes this utterance, it can shorten the psychological distance with him/her from the beginning of dialogue.

B. Natural Leading Without Feeling Intentional

After providing information on a recommended spot to the customer, the AR asks, “Does today’s dialogue make you want to visit the recommended spot?” The purpose of this question is to give the customer the impression that the customer had chosen the recommended spot by their own will. If a human asks this question, the customer would feel mentally pressured. However, since the AR asks this question, the customer would be more likely to believe that this question was not intentional, and the robot recommendation effect will increase further.

If the customer responds affirmatively to this question, the AR engages in free discussion related to the topic of the recommended spot. In case of the negative response, or if the customer wants information on the other spot (non-recommended spot), the free discussion is then related to the topic of the non-recommended spot. Although providing information on the non-recommended spot would cause the robot recommendation effect to be lower, this was done to follow a competition regulation stating that the customer was to check information on both spots.

IV. PROPOSED SYSTEM

In previous section, we discussed asymmetric communication such as tricky phrases that would be acceptable for humans. Then, in this session, we introduce AR’s behaviors and utterances aiming at human-likeness.
A. Character Transforming for Pretending to Tailor to Customer

A dialogue system should change its response in accordance with the customer’s internal state [7]. By clearly changing the AR’s attributes, personality, and interests to be tailored to the customer, as shown in the Fig. 4, the customer can gain a feeling of familiarity toward the AR. During the introduction in the dialogue, the AR says, “I will guide you with a character tailored to you,” and then transforms from a machine-like AR with a low voice and stiff tone of voice to a human-like AR with a high voice and soft tone of voice.

Although we could prepare several types of characters (shown in Fig. 4), a customer could not see others’ dialogues under the competition regulation. Therefore, the parameters of human-like and machine-like was consistently set to above mentioned condition through our preliminary round in DRC 2022 so as to analyze the experimental results easily. In spite of the consistency through all dialogues, we think all customers might regard the character change as robot’s serving for themselves.

B. Reducing Mental Stress in Customer

Unsmooth turn-taking may cause the customer to feel uncomfortable. Therefore, by clearly indicating the listening state of the AR, the customer’s mental stress can be reduced. Our developed transition chart was shown in Fig. 5. When the AR started to have a question, it leaned forward to indicate to the customer that turn-taking will be occurring. During the customer answering, the AR tilted its head at regular intervals to indicate to the customer that it was listening. After finishing the customer’s utterance, the AR nodded its head deeply twice to indicate to him/her that it was recognizing the utterance while generating next AR’s utterance.

C. Building More Natural Dialogue

If the AR only asked closed questions to customers, it could give the impression of interrogating them. In the dialogue, the AR asked open questions during chit-chat, which allowed customers to speak freely and get a good impression of the AR (Table I).

The important thing in a dialogue is to share and understand each other’s thoughts, so an AR should not speak
I want to go with friends. (How much are the fees? Germany.)

Fig. 4. Transition in robot’s internal states during a 5-minute dialogue. Robot takes M (machine-like) mode at beginning and end of dialogue, and H (human-like) mode between them. Machine-like character is transformed to human-like character so that customer can feel that AR is serving him/her.

Fig. 5. Transition of AR’s movements for smooth turn-taking.

and ask questions unilaterally. The dialogue of the proposed system incorporated free discussion in which the customer’s questions are answered, so we aimed to achieve this kind of dialogue (Table I).

The AR needs to respond naturally to the customer’s free utterances. In some cases, the AR responds to the customer’s utterances using sentences generated by the model for chit-chat dialogue system [8].

V. ANALYSIS OF RESULTS

Questionnaire results from the competition are shown in Table II. The definition of detail items in this questionnaire are shown in the overview paper [3]. In order to evaluate the asymmetric communication, we focused on three items of “satisfaction with the dialogue (Sat/d)”, “trustworthiness (Tru)” and “the robot recommendation effect (Recom)”. The former two scores (Sat/d and Tru) of our system were higher than ones of the baseline system, showing 5.0 ± 1.6 > 4.1 and 4.5 ± 1.9 > 4.3, respectively. The last (Recom) which means the degree of success to lead the customer to the recommendation spot was also higher than baseline, showing 11.5 ± 26.2 > 5.4. These results showed our dialogue strategy may be effective. The other scores which seemed to have no significant difference from baseline will be discussed in the future work with other teams’ data.

We watched videos of dialogues with customers that had a low evaluation. From the videos, we confirmed cases of dialogue breakdown due to errors in the speech recognition software and the fashion item detection module, as well as cases in which the speech synthesizer misread the generated sentences.

A total of 29 dialogue evaluations of our system were conducted in one day. Looking at the questionnaire results over time, there were 9 later cases for which the results were especially low. The experiment was conducted on a holiday, so the environment in the latter half of the day was noisy. This may have reduced the customers’ ability to concentrate on the dialogue, resulting in lowered evaluations.

| TABLE I | EXAMPLE OF THE DIALOGUE DURING OPEN QUESTIONS FROM THE AR. |
|---------|------------------------------------------------------------|
| Sys     | Now, I would like to ask you a few questions so that I can recommend a spot! First, What past trips do you remember? (では、これからお薦めの観光地を提案するために、あなたについていくつか聞ききます。まず、あなたの思い出に残っている旅行先はどこですか？) |
| Cus     | Germany. (ドイツ)                                          |
| Sys     | Germany sounds great! So, what do you remember about Germany? (ドイツがいいですね！ じゃあ、ドイツへの旅行ではどんなことが思い出に残っていますか？) |
| Cus     | I remember seeing castles, eating meals, and riding the train. (ドイツにしかない城を見てご飯食べたりしたこと とかは電車に乗ったこととか覚えています) |
| Sys     | I want to go on the trip with you! What German castles look like. Who would you like to go on the trip with? (ドイツのお城どんなふうになってるのか気になります 今日は考える旅行は誰と行きたいですか？) |
| Cus     | I want to go with friends. (友達と行きたいです) |
| Sys     | So you are traveling with friends. (友達との旅行なんですね。) |

| TABLE II | EXAMPLE OF THE DIALOGUE RESPONDING TO CUSTOMER’S QUESTIONS. |
|----------|-------------------------------------------------------------|
| Sys      | So, do you have any questions about Tokyo Trick Art Museum, such as fees or the parking area? (では、東京トリックアート美術館について、料金や駐車場など質問はありますか？) |
| Cus      | How much are the fees? (料金はいくらですか) |
| Sys      | High school students and older are 1,000 yen, 4 years old to junior high school students are 700 yen, and children under 3 years old are free. Do you have any questions? (高校生以上1,000円、4歳から中学学生が700円、3歳以下は無料です。他に質問はありますか？) |
| Cus      | Where is the nearest station? (最寄り駅はどこですか) |
| Sys      | It is a 2-minute walk from Odaiba Marine Park Station on the Yurikamome Line or a 3-minute drive from Daiba Gateway on the Metropolitan Expressway. (ゆりかもめ「お台場海浜公園駅」徒歩2分。または首都高速「台場出入口から3分です。) |
TABLE III
I\MPRESSION EVALUATION OF THE DIALOGUE AND THE ROBOT
RECOMMENDED EFFECT BY THE QUESTIONNAIRE SURVEY FROM 29
CUSTOMERS. BASELINE SYSTEM IS GENERAL RECOMMENDATION
DIALOGUE SYSTEM CREATED BY ORGANIZERS. SAT/C, INF, NAT, APP,
LIK, SAT/D, TRU, USE, REU, AND RECOM DENOTE SATISFACTION WITH
CHOICE, INFORMATIVENESS, NATURALNESS, APPROPRIATENESS,
LIKEABILITY, SATISFACTION WITH DIALOGUE, TRUSTWORTHINESS,
USEFULNESS, INTENTIONS TO REUSE, AND ROBOT RECOMMENDATION
EFFECT, RESPECTIVELY.

| Questionnaire items | Proposed system mean±SD | Baseline system mean |
|---------------------|--------------------------|----------------------|
| Sat/C               | 4.7±1.6                  | 4.2                  |
| Inf                 | 5.0±1.7                  | 4.0                  |
| Nat                 | 3.9±1.6                  | 3.8                  |
| App                 | 4.5±1.7                  | 4.4                  |
| Lik                 | 4.7±1.7                  | 4.6                  |
| Sat/d               | 5.0±1.6                  | 4.1                  |
| Tru                 | 4.5±1.9                  | 4.3                  |
| Use                 | 4.9±1.4                  | 4.7                  |
| Reu                 | 4.6±1.8                  | 4.1                  |
| Recom               | 11.5±26.2                | 5.4                  |

VI. CONCLUSION

We developed a hybrid system of human-like and
machine-like AR for DRC 2022 that has behaviors/utterances
that are as smooth and natural as possible while focusing on
asymmetric communication. Our AR started with a machine-
like character and transformed its voice tone and sentence
expression in order to tailored to each customer. This resulted
in the customer’s reaction being one of surprise or laughter.
Some tricky phrases for our experimental purpose, such as
questions related to customer privacy and forceful requests
for agreement, had a certain effect on customer’s feeling of
pleasure, reducing psychological distance and stress.
Although we still need further analyses, from an overall
subjective evaluation after a 5-minute dialogue, the good
scores for “satisfaction with dialogue,” “trustworthiness,” and
“robot recommendation effect” suggest that our asymmetric
communication system would be acceptable for humans
nowadays.

REFERENCES

[1] S. Nishio, H. Ishiguro, N. Hagita, “Geminoid: Teleoperated Android
of an Existing Person,” Humanoid Robots: New Developments, pp.
343–352, 2007.
[2] D. F. Glas, T. Minato, C. T. Ishi, T. Kawahara, H. Ishiguro, “ERICA:
The ERATO Intelligent Conversational Android,” In Proc. of 25th
IEEE International Symposium on Robot and Human Interactive
Communication (RO-MAN), pp. 22–29, 2016.
[3] T. Minato, R. Higashinaka, H. Nishizaki, T. Nagai, K. Sakai, T.
Funayama, “Overview of Dialogue Robot Competition 2022,” In Proc.
of the Dialogue Robot Competition 2022, 2022.
[4] R. Higashinaka, T. Minato, K. Sakai, T. Funayama, H. Nishizaki,
T. Nagai, “Dialogue Robot Competition for the Development of an
Android Robot with Hospitality,” In Proc. of IEEE 11th Global
Conference on Consumer Electronics (GCCE2022), 2022.
[5] M. Kawamoto, D. Kawakubo, H. Sugiyama, M. Shuzo, E. Maeda,
“Multi-modal Dialogue Strategy for Android Robots in Symbiotic
Society,” In Proc. of The 36th Annual Conference of the Japanese
Society for Artificial Intelligence (JSAI 2022), 2NS-OS-7a-02, 2022.
(in Japanese)
[6] M. Bono, “Can a Robot Join an Idobata Kaigi?: A Fieldwork on
Theatrical Creation of Daily Conversation,” In Proc. of the 32nd
Annual Meeting of the Japanese Cognitive Science Society, Vol. 22,
No. 1, pp. 9–22, 2015. (in Japanese)
[7] R. Tanaka, S. Kurohashi, “Modeling and Utilizing User’s Internal
State in Movie Recommendation Dialogue,” arXiv preprint
arXiv:2012.03118 2020.
[8] H. Sugiyama, M. Mizukami, T. Arimoto, H. Narimatsu, Y. Chiba,
H. Nakajima, T. Meguro, “Empirical Analysis of Training Strategies
of Transformer-Based Japanese Chit-Chat Systems,” arXiv preprint
arXiv:2109.05217 2021.