別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Cooperative Interactions Generated by Incompleteness in Robots' Utterance

Approx. 800 words

The conversation has always got attention as a way for people to interact with systems naturally. Improvements in machine learning have made it possible for systems to understand human speech and human intentions. Therefore, systems such as smart speakers have become commonplace. It is important to clarify the role of people and systems. The basis of the interaction is that the person speaks commands, and the system understands them. The system has focused on specializing its functions on an individual, such as recognizing speech and understanding intention of one person. However, Mikhail Bakhtin mentioned that incompleteness is crucial in interacting with others, beyond conveying information. The incompleteness is a factor that allows the speaker to give the other person a new interpretation of part of the text. He said that incompleteness is a chance to create new meanings with them. According to Lotman, the information function of conversation and relationship-building function are not two separate things. For Human-Computer conversation development, it is necessary to evolve the system conversation discussing the relationship-building function that involves a person, aiming at conversation created with others. This study tested a method to prepare for ambiguity, which has not been discussed and examined its effects.

First, we investigated the structure of speech in asymmetrical relationships between people and the practice of eliciting others' participation in conversations. We could see the practices as other-initiated repairs and fishing-devices that encourage others' participation in our daily conversations. For example, sociolinguistic science described telling part of the story as a trigger to elicit participation from those who have more responsibility. In this study, we developed an "incomplete utterance strategy" in which the robot's speech is made lacking by removing additional pieces of information from its speech. The possibilities and effects of this speech strategy were investigated through three experiments.

Then, to investigate the validity of the incomplete utterance method, two strategies were tested. We compared human behaviors between two conditions, one semantically incomplete utterance and structurally incomplete utterance in human-robot conversation. The results showed that people increased their responses to the semantically incomplete robots through active participation in the conversation (questions, the introduction of new content related to the conversation). Next, we examined what impressions were obtained from conversations between humans and incomplete utterance robots. We used two of the most average interactions from the last experiment. We asked for new participants to evaluate the two conversations. The results showed that participants perceived conversations with humans and semantically incomplete utterance robots as cooperative. Finally, I tackled the question: Can an incomplete utterance elicit human involvement? We analyzed whether incomplete utterances elicit human participation in terms of changes in participation attitudes. A

multi-party conversation was set up to analyze the changes in participation attitude. Den reported it is easier to change participation in a multi-party conversation than in a one-to-one conversation. The experiment set up a multi-party conversation between a speaker robot, a listener robot, and a participant. The participants could choose to explain with the speaker robot or listen with the listener robot. We compared impressions and behaviors between the semantically incomplete utterance robot and the fully explaining robot. Results showed that people increased their participation as the speaker with incomplete utterance robot. Furthermore, they decreased their participation as the listener also. Besides, it was confirmed if the robot spoke incompletely, but participants joined the conversation, the rate of information transfer is estimated the same as the fully explained robot. However, this study found that this incomplete utterance method had limitations. It requires the speaker robot to select a person as the next speaker directly. The impression showed that although participants increased their speech amount with incomplete utterance robot, they did not feel like they were explaining together, which is a subject for future research.

We tested the incomplete utterance robot through three experiments. It was confirmed that the robot's incompleteness changes human behavior and participation attitude w hen the robot tries to engage directly with a person. The result also showed that com munication efficiency does not change if humans participate, even if the robot falls sh ort of words. So, it is possible to use this technology as an interaction technique to el icit human participation. However, this study's implementation was not enough to disc uss collaborative actions. It will be necessary to examine the model for long-term impl ementation in the future.
In recent years, robots that do not speak Japanese at all on purpose have been commercialized and are gaining popularity in Japan. A robot that conveys information accurately and has space for people to interact will continue to attract attention in the future. This study proposed a new conversational design, which is speech incompleteness. We investigated its effects and limitations. This result may contribute to the engineering field's development as a basis for the next generation of interaction technology for human-interactive systems.