

研究報告書

「多言語コラボレーションにおける非母語話者の貢献支援」

研究期間：平成29年10月～平成31年3月

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1. 研究のねらい

This research aims to develop novel tools to support communication and collaboration between native and non-native speakers of a language. The focus in this research is on supporting verbal and non-verbal communication during multilingual face-to-face meetings in order to aid non-native speakers in contributing their ideas to the discussion. Secondly, this research aims to support non-native speaker contribution and reduce misattributions made by native speakers in multilingual text-based group chats by detecting and sharing awareness feedback of non-native speakers' language difficulties in real-time.

2. 研究成果

(1) 概要

The aim of this research is to alleviate the problems non-native speakers of a language experience when trying to contribute their comments, opinions and ideas to the other members of a multilingual group. The research focuses on two modalities: face-to-face meetings (Theme A) and text-based group chat (Theme B). The objective in this project is to develop novel supporting technology for multilingual meetings where non-native speakers are a minority.

The focus of this research is on both the native and non-native speaking group members. That is, the goal in this research is to explore how to 1) automatically detect non-native speaker's status, 2) share this information with native speaking participants, and 3) influence the behavior of multilingual group members to include all participants equally in the collaboration.

(2) 詳細

Theme A-1: Development of Table-top Robot System to Support Non-Verbal Multilingual Communication in Face-to-Face Meetings

Development of a table-top robot prototype and sensor system for detecting user's non-verbal behaviors in real time was completed. A group of three table-top robots 'mimic' users' nodding behaviors in real-time based on data from a specialized face-tracking software (Figure 1). The system allows group members to monitor their own and each other's non-verbal behaviors from a third-person view during a face-to-face meeting based on the nodding 'mimicked' by each robot assigned to a human participant.



Figure 1. Table-top robot system prototype using specialized face-tracker software to ‘mimic’ users’ non-verbal behaviors.

The system was evaluated in a series of group discussion experiments, where participants with disparate language abilities discussed a given topic. The results suggested that the table-top robot system influenced both native and non-native speakers’ awareness of their own as well as other group members’ non-verbal communicative behaviors, and that these awareness effects persisted in subsequent face-to-face discussion sessions without the support system. This indicated that the type of feedback provided by the table-top robot system could be used to influence long-term non-verbal behaviors of users during face-to-face meetings.

Theme A-2: Development of a Mobile Application for Automated Real-Time Detection of Difficult Second Language Words during Multilingual Face-to-Face Meetings

Development of a mobile application that automatically detects, displays and translates difficult to understand second language words during face-to-face meetings based on the user’s second language ability was completed (Figure 2). The objective was to provide non-native speakers a method to check their understanding of second language words used by native speakers in an alternative modality, and quickly resolve any comprehension problems that might occur, and thus aid their contribution to the multilingual discussion without increasing their mental workload.



Figure 2. Mobile application that automatically detects, displays and translates difficult second language words during face-to-face meetings based on user’s second language ability.

The system was evaluated in a non-interactive setting, where non-native English speaking participants watched video clips of second language group discussions. The results suggested that the introduction of the system may increase comprehension of second language group discussion content while having no negative affect on the cognitive load experienced by the users.

Theme 2: Development of an Awareness Display for Text Chat Applications to Support Multilingual Text-based Communication

Development for a text chat application that monitors non-native speakers' actions that are normally invisible to other group members (e.g., machine translation use, reading messages) in text chat environments was completed. In this system, the approach is to display detailed information about non-native speaker's behaviors to native speaking group members in order to aid with the pacing and group dynamics in text-based multilingual collaboration, and influence the attributions native speakers make on the challenges non-native speakers face that may affect interpersonal attraction. The approach is to detect non-native speaker's behaviors that affect the latency of their contribution to the discussion, and display an abstraction of this information to native speakers in real-time.

As part of the system development process, a technology installation exploring the effects of awareness about non-responsiveness in text-based chat was displayed (Figure 3).



Figure 3. “Absent from Present” installation.

3. 今後の展開

Collaborations between people who do not speak the same native language are likely to only increase in the future. While technologies such as machine translation are useful for overcoming the language barrier when collaborators do not share similar language abilities, currently these technologies only support verbal (i.e., voice or text) communication. My vision on the future of multilingual collaboration support is that non-verbal communication with and without verbal communication support tools (e.g., machine translation, automated speech recognition) will become increasingly important in order to preserve the practical effectiveness of collaborative environments. Moreover, the use of verbal communication support tools will subsequently increase the amount of non-verbal cues that communicators have to monitor making it even more challenging to keep track of group members' status and collaborate efficiently, particularly in face-to-face settings.

However, supporting non-verbal communication is not as straightforward as with verbal communication. Behaviors such as nodding or eye contact communicate rich information to other collaborators regarding a person's status, but are both largely subconscious and often tied to a culture, language, or in some cases the communication tool itself. Hence, invasive or explicit methods that aim to

directly influence users' non-verbal behaviors may be more distracting than effective as users may either feel coerced to act in a way that feels unnatural to them, or perceive that their privacy is invaded by the feedback given to others.

On the other hand, approaches that are largely invisible when not needed, but provide meaningful real-time feedback when collaborators have to be aware and react to their own or others' status may be more successful when supporting non-verbal communication. For example, instead of a system explicitly telling collaborators that one of their group members is having trouble understanding what is being said, a non-verbal communication support system could subtly draw the attention of the group members to the differences in how native and non-native speakers react and behave during discussions.

I believe these type of approaches may lead to better quality collaborations without increasing the cognitive load of users of the system. Along with improvements in verbal communication support performance, systems that improve collaborators understanding of other's non-verbal communication cues will help overcome the language barriers in multilingual organizations, lower the threshold for adopting multilingual communication and collaboration support tools in daily activities, and significantly reduce misattributions and negative outcomes caused by verbal or non-verbal miscommunications.

4 . 自己評価

Theme A-1

- The development of a table-top robot system that increases the users' awareness of other group members' non-verbal behaviors during multilingual face-to-face meetings was achieved (research goals 1 and 2).
- As of writing this document, unfortunately the data analysis is still partially underway regarding the effects on the distribution of discussion contributions among multilingual group members (research goal 3), which will be disseminated in a journal paper.
- Robot design that may be effective in influencing user's non-verbal behaviors was achieved (research goal 3). However, further research is required to improve on the present design. Based on the comments from non-native -speaking experiment participants, feedback on head turning may be more effective than nodding during face-to-face discussions. To realize this, improvements on the face-tracking system are needed, for example, by utilizing depth cameras.
- Experiment comparing the effects of feedback from a table-top robot and feedback from a traditional display started at the end of the fiscal year, but will continue towards the next fiscal year as of writing this document.

Theme A-2

- The development of a mobile application that automatically detects and displays difficult to understand words in real-time to aid non-native speakers in face-to-face meetings was developed.
- Presently, only a non-interactive experiment has been conducted to investigate the effects of the system on non-native speakers' comprehension of second language group discussion.

- Interactive experiment investigating the effects of the system on non-native speaker contribution will be conducted with foreign students arriving to Japan.
- Instead of targeting non-native English speakers, this system is likely better suited for foreign students in countries that do not use the roman alphabet, such as Japan.

Theme B

- A text-chat awareness display system that detects non-native speakers' status during multilingual group chats was developed (typing, reading, translating).
- Based on this theme, an interactive installation was displayed in iii Exhibition 2018.
- Preliminary experiment results suggest that displaying awareness information about non-native speakers' status during text-based group chats may have a positive effect on native speakers' interpersonal and task attraction towards the non-native speaker. However, further data collection is needed to confirm the hypothesis.

・研究の進め方 (研究実施体制及び研究費執行状況)

Research on all themes is continued by the principal investigator and two master's students who will complete their master's theses research based on two of the sub-themes (expected graduation: March, 2020).

Theme A-1

- Experiment results with the latest table-top robot system are currently being disseminated into journal publication.
- This project will continue to improve the robot design and sensor system, as well as increase the number of non-verbal communicative cues displayed by the system.
- An experiment comparing the physical table-top robot system and traditional display as a means to provide feedback on non-verbal communication during multilingual face-to-face meetings will continue in April 2019.

Theme A-2

- The system for automatically detecting difficult second language words will continue as a collaborative project, and will be evaluated with foreign students in Japan in a separate experiment.
- Based on further experiment results, the system will be promoted and made available as a supporting tool for foreign students in Japanese universities.
 - o We are currently designing faster ways for non-native Japanese speakers to understand the meaning a of a word rather than direct machine translation.
- This approach will also be implemented in a video conferencing system.

Theme B

- The research and development results for the awareness display during multilingual text chats

inform the development of a Slack extension, which is planned to be made available for Google Chrome version of Slack as open source software (late 2019).

・研究成果の科学技術及び学術・産業・社会・文化への波及効果

Theme A-1

- Results from this research suggest that the table-top robot system may be helpful for supporting non-verbal communication in real working groups, and in larger scale. That is, as the number of people in a multilingual group increases, the harder it is to monitor everyone's status during a group discussion, and the table-top robot system maybe more effective in these contexts.
- However, development of such a large scale system is challenging and requires industry collaboration.

Theme A-2

- A system that detects and displays difficult words to non-native speakers may be most useful for foreign students in countries such as Japan and China, which do not use roman alphabet. A system that helps foreign students to comprehend discussion content and contribute to the discussion more effectively would likely alleviate challenges in cultural adjustment, make them feel more included in the local community or group, and have a positive impact on their mental health.
- This system could also help tourists who have rudimentary understanding of Japanese language. That is, instead of directly translating everything that was said by a native speaker, this system will help the non-native speaker to resolve only the parts of a conversation they did not understand. This might be a less invasive way to support multilingual conversations.
- This system could be further used as a tool for second language learning, where users could review the words they did not understand, learn them and subsequently improve the individual detection accuracy of difficult to understand words based on the learning outcomes.

Theme B

- The text-chat system that shares awareness data on non-native speakers status may be most helpful in academic laboratories with foreign students by helping the native speakers adjust their behavior and attitudes towards the foreign students with language difficulties. This might in turn aid in their cultural adjustment, and help them feel more included in the local community.

・研究課題の独創性・挑戦性

Theme A-1

- To the best of my knowledge, this research theme is the first to explore how to support non-verbal communication in multilingual face-to-face meetings using ICT.
- This research is the first that will report on the effects of feedback on users' non-verbal behaviors

that persist to subsequent discussions (publication underway).

- This topic is very challenging due to the subconscious nature of non-verbal cues, and the interconnected challenges in technology development.
 - o Discovering a robot design that elicits a sense of embodiment (appearance, movement, etc.), and is robust enough for use in real-life environments.
 - o Developing non-intrusive sensors that produce minimal delay, while being able to detect subtle non-verbal cues (e.g., nodding) and filter out noise.
 - o Balancing users' privacy concerns (e.g., with machine learning approaches) with detection accuracy.
 - o Combining sensor data with robot actuators with minimal delay, noise and detection errors.
 - o Designing a robot frame that is robust enough to handle actuator feedback, and at the same time elicits a sense of embodiment.
- Experiments are currently underway to investigate the differences between feedback from a physical robot as opposed to feedback given through a traditional display, which will be the first study of its kind.

Theme A-2

- A system that automatically displays words based on user's second language ability, as opposed to full transcripts, is a novel tool in any communicative context (i.e., face-to-face, video, audio, text chat).
- One challenge for the system would be to improve the accuracy of what words are considered "difficult" for any one user, and may require the development of a learning algorithm.

Theme B

- No system is currently publicly available that would display the detailed status of a conversational partner during text chats.

5. 主な研究成果リスト

(1) 論文(原著論文)発表

- | |
|---|
| 1. Hautasaari Ari, 多言語コラボレーションにおける非母語話者の貢献支援、苗村研究室オープンハウス2018、東京大学。(ポスター) |
| 2. Hautasaari Ari, 多言語対面会議における非言語情報を顕在化する卓上アバターの実装、苗村研究室オープンハウス2019、東京大学。(ポスター) |
| 3. Yamaguchi Saho, 多言語対面会議のための難単語翻訳インターフェース、苗村研究室オープンハウス2019、東京大学。(ポスター) |

4. Ishiyama Kuntaro, 多言語コミュニケーションのための相手の気づきを促進するテキストチャットインターフェース、苗村研究室オープンハウス2019、東京大学。(ポスター)

5. Yamaguchi Saho, Ishiyama Kuntaro, Miyashita Tamami, Tanaka Takuro, Ari Hautasaari, "Absent from Present," The University of Tokyo 20th iiiExhibition "Dest-logy REBUILD". (作品)

(2)特許出願:0件

(3)その他の成果(主要な学会発表、受賞、著作物、プレスリリース等):0件