

An Investigation of Haptic Interaction in Online Negotiation between different native language people

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Abstract Due to the development of internet technology, the online business trade becomes an active area. Online negotiation supporting systems have been developing very actively in recent years to meet the growing needs. We have been studying on the effect that the haptic device brings about in interaction through online negotiation between two parties. In order to meet the online negotiation's requirements, the developed interface should be able to protect user's anonymity, convey user's emotion and make the scene alive. In this study, we adopt haptic interaction as a means of conveying emotion in an online negotiation between Japanese and Chinese people. In this study, our goal is to investigate the effectiveness of haptic interaction in communications between Chinese and Japanese users and analyze the characteristics in operation the haptic device. We conducted online negotiation experiments with and without haptic interaction. The comparison experiments results show that the haptic feedback can help to convey the emotion and the sense of presence. The Chinese subjects' feedback for the questionnaire concerning the emotional communication and the sense of presence varies slightly compared to the Japanese subjects. We also found when using the haptic device, the force feedback can influence subject's feelings. There is little significant difference between the advanced and the medium subjects in negotiation dialogues and the haptic device's operation, the beginner subjects are slightly at a disadvantage.

1. Introduction

Internet technology develops rapidly nowadays. Online conversation conducted via internet is not uncommon. In recent years, online communication system developing becomes very actively. In addition, the internet environment is virtually getting ready for conducting online negotiation between the distant users.

We have been doing research on the effect that the haptic device brings about in interaction through online negotiation between two parties. In order to

meet the online negotiation's requirements, the developed interface should be able to protect user's anonymity, convey user's emotion and make the scene alive. In our former study [1] (Fig 1), between the subjects who have the same cultural background, the experimental results implied that while using the haptic device during an online negotiation, the nonverbal information can be conveyed more naturally and directly. Meanwhile, users can feel higher sense of presence compared to the experiments without haptic feedback.

However, when being with someone from different language background, due to the inadequate linguistic proficiency, people are likely to have difficulty in conducting communications,

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especially those for solving troubles. Commonly, to gain a better understanding, people communicate through some body languages, which is a good way to convey nonverbal information. Nevertheless, when having an online negotiation, compared to the face-to-face communication, the lack of nonverbal information as well as the sense of presence would cause a conversation to be far from smooth. In this case, if we apply a haptic device in online negotiation, it can be expected to be more beneficial and helpful for online negotiation.

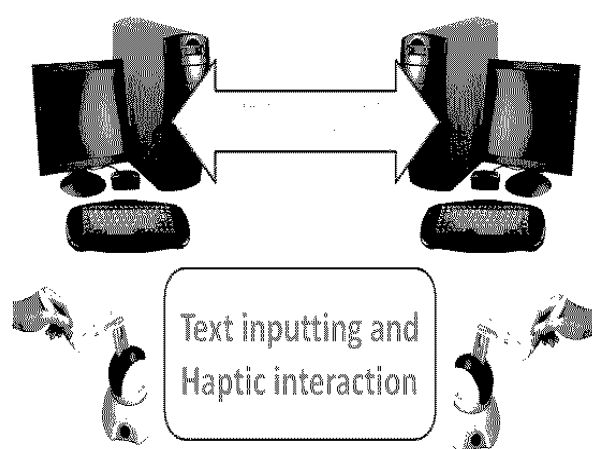


Figure 1. The display interface for the online negotiation involving haptic interaction.

In this study, our goal is to investigate the effectiveness of haptic interaction in communications between Chinese and Japanese users. We conducted two types of online negotiation experiments, for the negotiation is more likely to be emotional and controversial. Also we analyzed the way that the Chinese subjects operate the haptic device due to the difference in linguistic proficiency. The experimental results implied that using the haptic device during an online negotiation, the nonverbal information can be conveyed more naturally and directly. There is little significant difference between the advanced and the medium subjects in negotiation dialogues and the haptic device's

operation, the beginner subjects are slightly at a disadvantage.

2. Related work

2.1 The function of negotiation

Negotiation has been defined by Pruitt as "a discussion between two or more parties with the apparent aim of resolving a divergence of interests" [2]. It is a process that starts reaching agreement by exchanging the proposal and the opinion among the people who have different sense of values. It is an effective way of solving the conflict existing in various social activities. Therefore, the legal dealing, diplomacy and the transaction etc. can be characterized as the negotiations.

Nonverbal information plays a very important role in face-to-face negotiations [3]. Even a slight change in the expressions of joy and anger could change one's impressions, or even lead to a satisfactory conclusion or a breakdown. As another point of view, if the users can make better use of facial expressions, the negotiation can be pushed forward smoothly.

2.2 Online negotiation supporting system using a haptic device

Due to the development of internet technology, the online business trade becomes an active area. Therefore, online negotiation supporting systems have been developing very actively in recent years to meet the growing needs. Especially, the method of conveying nonverbal information has been significantly refined.

In our former research, we used PHANTOM haptic device [4] in online supporting system for two parties and realized the conveying of emotion

as well as the sense of presence (Fig 1). In the display interface, the user throws the ball to the other partner after sending the text statement. The alternation of making statements is visualized to the throwing ball back and forth in the interface. When user catches the ball using the haptic device, the force feedback can be felt. Besides, pushing the button on the pen device can switch the ball size from small to big in three steps. The force feedback changes with the ball size, which can be used as a means of conveying emotions and the mood atmosphere.

O. Oguz et al [5] also used PHANToM haptic device in multi-modal virtual environments to realize collaborate guidance involving haptic interaction. It introduces a more personal and human-like interaction model. In C. Basdogan's research [6], PHANToM haptic device was used to complete collaborative tasks in virtual environments. E.L. Sallnas [7] also studied on the virtual presence and task performance of haptic feedback in collaborative desktop virtual environment.

Obviously, if we use a video camera during an online negotiation, they can see their faces and all their gestures can be clearly shown on the PC screen as well as the voice. Without a doubt, this method can solve all the problems perfectly. However, from the standpoint of protecting one's privacy, as a matter of fact we avoid using video camera in some sensitive situation. Considering this issue, the technology of facial expression and motion recognition has already been studied [8]. Not only the facial expressions and body gestures can be recognized, but also the emotional factors can be extracted from these movements. Nevertheless, users need to perform extravagant gestures to maintain a high identification rate. Conversely, some malicious users would exploit it to send fake information with some "acting skills", which could make the negotiation untrustworthy. Therefore, we

are not concerned here with the application of video camera in online negotiation.

Thus the thoughts of introducing haptic technology into online negotiation systems happen spontaneously. Touch is expected to convey a great variety of meanings with emotions. We can express the anxiety or pleasure, as well as the intimacy by different force levels and frequency.

If the haptic technology is applied into the online negotiation system, it may bring some favorable influence to the online negotiation. Also, the integration of online negotiation and haptic interaction remains much to be learned. Therefore, in this study we specially focus our attention on how to improve the technique of conveying nonverbal information in online negotiation system.

3. The user interface using PHANToM haptic device

We utilize PHANToM Omni haptic device as a means to perform the haptic interaction. PHANToM Omni haptic device is possible for users to touch and manipulate virtual objects with hands. It has six degree-of-freedom positional sensing, with ability of producing high realistic tactile and force feedback sensations. This device can simulate wide choice of materials, such as frictionless plane, liquid, jelly-like substance, and even very stiff material. Using the two buttons on the pen device can make some events occur. We use IEEE-1394a FireWire port interface to connect it with PC.

In this study, we enabled the conveying of emotion more directly and naturally by the haptic feedback. The display interface is shown in figure 2. The user balls at each side of the interface represent both users, the statement ball is set between the user balls. By throwing the ball in the middle, we can realize a highly realistic 3D play

catch movement, the user can change the ball's size among small, medium and big by pushing the button on the PHANToM haptic device. The three size of ball is set 10, 20 and 30 respectively. While the two users are having an online negotiation, after sending a text message to the other side, and then throw the statement ball to the other side. Then another user who received the ball could feel the emotion level from the size of the ball as well as the realistic sensations by the haptic feedback, which changes with the size of the user ball.

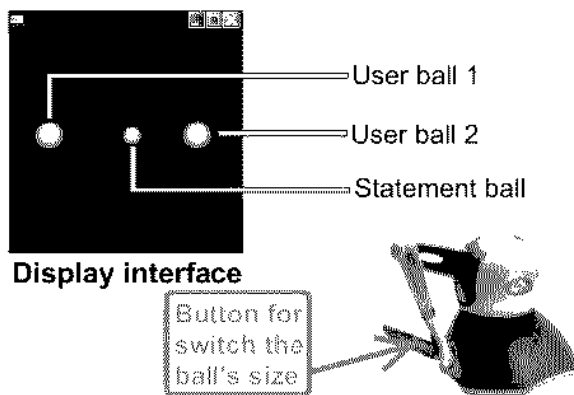


Figure 2. The display interface for the online negotiation involving haptic interaction.

We made the online chatting possible by Skype so that the text message function can be ensured. We maintain the graphics and haptic update rates at 1 KHz to keep a high frequency of update and eliminate inevitable time delays. We connect the two PHANToM Omni haptic devices on one PC instead of internet communication method. During the experiments using PHANToM haptic devices, we get the signals from a single computer and displayed same interface on two separate monitors to simulate a distant situation [9].

4. Experimental Setting

4.1 Experimental Objects

In this section, we explain objects of this experiment. In order to investigate whether the haptic interaction can be effective for resolving the cultural difference between the Japanese and Chinese people, and to observe whether there are any features appears in intercultural online negotiations, we conducted two types of online negotiation experiments to investigate the effectiveness of haptic interaction. In order to make the conversation more emotional and controversial, we made a case for this experiment, which is taken from a true story, and let the subjects to play the seller and winning bidder to conduct the negotiation. We classified the Chinese subjects according to their Japanese linguistic proficiency analyzed the factors contained in the dialogues, respectively.

4.2 Experimental setting

A total of 20 subjects (three females, 17 males) were recruited for this study. Most of them are graduate students, ranged in age from 22 to 27 (mean 23). Most of the participants are with little experience of using the online mediation system as well as the PHANToM haptic device. Each pair consists of one Japanese student and one Chinese student. They become seller and winning bidder, and perform two online negotiations. All the participants took part in the two kinds of experiments below:

- (1) Text inputting negotiation without haptic interaction;
- (2) Text inputting negotiation involving haptic interaction.

In both experiments, the subjects have to use the PHANToM haptic device during the online negotiation. The only difference is that in experiment (2), the user cannot felt any haptic force

feedback. All the online negotiations are conducted in Japanese. The Chinese subjects' Japanese skills differ from each other.

4.3 Subject (Scenario) of online negotiation

In this section, we explain the case we use in the online negotiation experiments, as well as the factors we associated with the case. We made a case for this experiment, which is taken from a true story:

Y auctioned a second-hand automobile muffler on an online auction site. However, the material is not mentioned clearly in the item description. Y emphasized that [The bidder is supposed to check the product's homepage in advance. No refunds, no exchange.] Moreover, three unclear images are placed on the web pages. A few days later, this item was sold for 20,000 yen. After the payment is confirmed, Y sent it to X's address, who is the winning bidder. 2 months passed, and X sent an email to Y. X won the bid not knowing it is Ulster made, and X wants Y to pay for the damage.

In the CATO system of Alevel [10], a case base is manually analyzed, and factors are associated with the cases. In order to summarize the negotiation dialogues and observe the spread of topics appeared in the negotiation according to different Japanese level, the 15 factors listed below are extracted from the case in advance. This can help us to investigate which topic is mostly discussed:

F1 The automobile muffler is Ulster made.

F2 The item description for material is not clear. Moreover, it is difficult to judge the material from the unclear images.

F3 The item description and the image for material is clear enough. The bidder should check the product's HP in advance.

F4 Only stainless mufflers are listed in Z's HP as

well as the latest catalog. There used to be some Ulster made mufflers in the past few years.

F5 This muffler is incompatible.

F6 Winning bidder's car is a tool of trade. If it cannot be solved rapidly, it will be a matter of life and death.

F7 After 2 months, Y received the claim from X.

F8 X wonders whether it is Z's product, for there is neither any stamp of the maker, nor any manufacture's serial number.

F9 The item has no manufacture's serial number because it was a special order product as a sample.

F10 Negative feedback

F11 No refunds, no exchange

F12 Require refunds or exchange

F13 The seller don't have enough money to afford the refunds.

F14 The winning bidder's fault.

F15 The seller's fault.

We showed the relation among all the factors in figure 3. The arrow pointing one factor indicates the supporting relationship, while two factors between an bi-directional arrow represent the conflicting factors. Three pairs of factors are key conflicting factors: F2&F3, F11&F12, F14&F15. They are important factors predisposing to be the point of issue. When the subjects are conducting an online negotiation, they are likely to use these relation to argue with the other side. However, before the experiments, we didn't tell the relation among the 15 factors to the subjects.

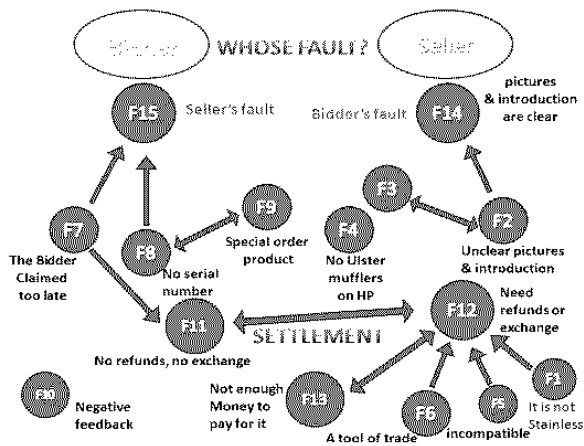


Figure 3. The example of factor relation.

4.4 Evaluational methodology

After the experiments, all the subjects answered for the questionnaire, Q1 to Q13 are supposed to be rated on a 8 point scale. The questions are listed below:

- (1) The expression of emotion in the online negotiation:
 - Q1: To what extent you felt the other one's emotion?
 - Q2: To what extent you conveyed your feelings?
 - Q3: Did you make your intention clear?
 - Q4: The importance of emotion.
- (2) The sense of presence in the online negotiation:
 - Q5: To what extent you felt the sense of presence?
 - Q6: The importance of sense of presence.
- (3) The smoothness, satisfaction and concentration about the negotiation:
 - Q7: Did it go smoothly as you expected?
 - Q8: Are you satisfied with the result?
 - Q9: Are you able to concentrate on the online negotiation?

- (4) The operation of the PHANToM haptic device:
 - Q10: Do you think the haptic interaction requires longer time?
 - Q11: Is the throwing ball back and forth operation natural?
 - Q12: Is the haptic interaction helpful to online negotiation?
 - Q13: Did your hands wear out?

5. Experimental results

5.1 The Effectiveness of haptic interaction in online negotiations

Table 1 shows the results of questionnaire concerning the emotional communication and the sense of presence. "V+H" and "V only" stands for "negotiations with haptic interaction" and "negotiation without haptic interaction", respectively. We compared the results of negotiations using the PHANToM haptic device with the result of negotiation without it between Chinese and Japanese subjects. The word "emotion" mentioned in Q1, Q2 and Q4 doesn't equals to concrete emotion. It is closer to mood expression.

From Q1 to Q4, the results imply the expression of emotion goes better in the online negotiations with haptic interaction. When involving haptic interaction, the average value for the expression of emotion is bigger than 6, which differ significantly from the negotiations without haptic interaction. While comparing the mean value of Chinese and Japanese subjects, especially for Q1~Q6, the mean value of Japanese subjects in "V only" situation is about one less than that of Chinese subjects. In Q4, both Chinese and Japanese subjects have a tendency to put the emotion expression in an important position, although the mean value of Japanese subjects is much lower. Also, the same

situation exists in Q6. While comparing the standard deviation value, it is clear that the standard deviation of Chinese subjects is smaller than Japanese subjects. Moreover, for Chinese subjects, the feedback varies more slightly in "V only" situation except for the Q2. For Japanese subjects, only in Q9 the standard deviation of Japanese subjects is a little higher in "V only" situation. This results implies that in online negotiation with haptic interaction, the force feedback makes the emotion expression and sense of presence conveyed more directly, thus these subjects have similar impression. By the haptic device, the subjects are able to express their feelings more directly and smoothly, and haptic interaction makes the scene alive. In contrast, for Chinese subjects in Q8 and Japanese subjects in Q9, respectively, the difference of average value in

Table 1. The result of questionnaire concerning the emotional communication and the sense of presence.

		Chinese		Japanese	
		Mean	SD	Mean	SD
Q1	Vonly	5.4	0.966	4.3	1.947
	V+H	6.7	0.949	6.7	1.567
Q2	Vonly	5.0	1.054	3.8	1.687
	V+H	6.4	1.075	6.4	1.429
Q3	Vonly	4.4	2.011	3.7	2.497
	V+H	6.7	0.949	6.6	1.506
Q4	Vonly	5.0	1.563	3.6	1.713
	V+H	6.3	0.949	5.3	1.059
Q5	Vonly	4.6	1.429	3.7	1.703
	V+H	6.3	1.159	6.2	1.033
Q6	Vonly	4.6	1.776	3.7	1.767
	V+H	6.2	1.229	5.4	1.075
Q7	Vonly	4.9	1.729	4.6	1.897
	V+H	5.9	1.197	5.5	1.581
Q8	Vonly	6.2	1.476	5.4	1.647
	V+H	6.3	1.252	6.4	1.429
Q9	Vonly	5.7	1.829	6.4	1.265
	V+H	6.5	0.707	6.4	1.713

negotiations involving haptic interaction is not significant. The reason is considered to be influenced by user's operating the haptic device and inputting text messages alternately.

Table 2. The result of questionnaire concerning the operation of PHANTOM haptic device.

	Chinese		Japanese	
	Mean	SD	Mean	SD
Q10	4.6	2.271	4.1	2.132
Q11	3.8	2.098	4.8	1.476
Q12	5.8	1.687	5.2	1.135
Q13		0.707	2.5	1.900

Table 3. The time and number of statements from Group1 to Group10.

Group			Mean	SD
			1 to 5	Former
	V + H	statement	15.4	3.362
	Latter	time(min)	31.4	10.015
	V only	statement	11.2	5.263
Group 6 to 10	Former	time(min)	59.2	20.192
	V only	statement	15.0	7.348
	Latter	time(min)	52.2	13.349
	V + H	statement	14.2	3.701

The results of questionnaire concerning the haptic device's operation are shown in table 2. Although the average value of Q10 and Q11 imply that the play ball operation is comparatively helpful, the subjects also think this operation can be more natural and the operation cost more time inevitably. In Q13, It is likely that operating the haptic device is not a heavy burden at all for most of the Chinese subjects.

In table 3, we also took the statistic about the negotiation time and the number of statements in negotiations with or without haptic interaction, it is clear that the time reduced greatly in former haptic negotiation and latter negotiation without haptic. The number of statements also has a tendency to

decrease. However, in former negotiation without haptic interaction and latter negotiation with haptic interaction, the negotiation time has a tendency to decrease except the last pair. The possible reason is that in latter negotiation, the haptic interaction is helpful for activate the negotiation process and make the subjects to be as motivated as the former negotiation.

5.2 The analysis of negotiation dialogues and haptic interaction

In this section, we especially focus on the Chinese subjects' negotiation dialogues and the haptic feedback in each statement. As we assumed, it is possible that for some beginner in Chinese subjects, they would be likely to run out of topics because of their Japanese skills. Therefore, when we analyze the results, it is necessary to consider the difference in the Chinese subjects' Japanese linguistic proficiency, the spread of topic in their negotiations, and the changes in their emotion expressions.

We classified the 10 Chinese subjects according to their Japanese linguistic proficiency. There are 2 advanced, 4 medium, and 4 beginner subjects. The Japanese level is evaluated according to the criterion:

- (1) Advanced subjects: little Japanese grammar or spelling mistakes, very good at Japanese.
- (2) Medium subjects: some grammar mistakes, they are able to make intentions very clear in negotiation.
- (3) Beginner subjects: More grammar mistakes or misunderstanding in making intentions. Some of them need to use electronic dictionary during the negotiation process.

In Figure 4, we collected all the factors which are mentioned in Chinese subjects' statements, and it is the statistical results among the advanced, medium

and beginner subjects. The statements without any factors are omitted. The figure indicates that the beginner subjects almost covered all the factors. In contrast, the medium and the advanced subjects only mentioned some factors. It appears that the factors are not fully used for negotiation. However, because of the inadequate linguistic proficiency, when we focus on the point of issue

F2&F3, F11&F12, F14&F15, obviously advance and medium subjects mentioned more frequently in these conflicting factors. It implies that the negotiations conducted by advanced and medium subjects are activated and heated. This result offers a new insight into intercultural communications.

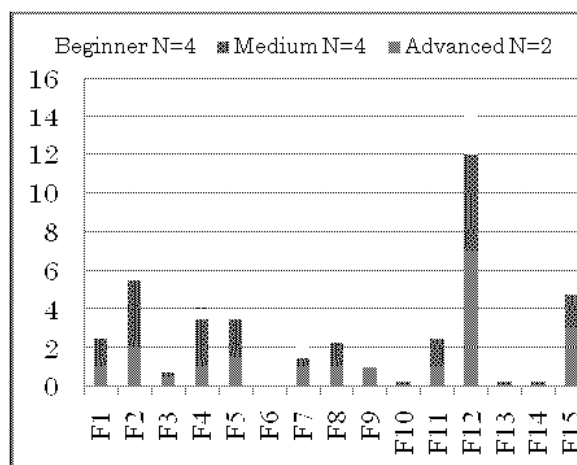


Figure 4. The average number of F1~F15 appeared in Chinese subjects.

In table 4, the distribution of ball size in negotiation with haptic interaction is listed. The "S", "M", "L" each stands for the ball size "small", "middle", "large". It is expected that the beginner subjects would make full use of the haptic device to cover the shortage of Japanese skills. Judging from the results, the beginners didn't mentioned enough issue point compared to other subjects even if they want to make full use of haptic feedback. When focussing on the conflicting factors, it shows the F12 is mainly discussed and appeared the most

in their negotiations. the distribution of ball size for F12 indicates that the advanced subjects didn't rely on changing the ball's size to emphasize ones' opinions and the medium subjects mainly used the middle size of the ball. In contrast, the beginners preferred small and middle size of the ball, for they have a tendency to show a more friendly attitude to the other side.

Table 4. The distribution of ball size in negotiation with haptic interaction.

	Beginner			Medium			Advanced		
	N=4			N=4			N=2		
	S	M	L	S	M	L	S	M	L
F1	0	1	1	2	2	0	1	0	0
F2	0	1	0	0	2	5	0	0	2
F3	1	0	1	0	0	1	0	1	0
F4	1	0	1	0	3	2	0	1	1
F5	0	0	0	1	2	1	0	1	0
F6	1	0	1	0	0	0	0	0	0
F7	0	0	0	0	0	1	0	0	1
F8	0	0	1	0	1	1	0	0	1
F9	1	0	0	0	0	0	1	1	0

6. Conclusions and future work

In this study, we investigated the effectiveness of haptic interaction in online negotiation between Chinese and Japanese subjects. The experimental results implied that using the PHANToM haptic device during an online negotiation, the nonverbal information can be conveyed more naturally and directly. Although there is little significant difference between the advanced and the medium subjects in negotiation dialogues and the haptic device's operation, the beginner subjects are slightly at a disadvantage. Closing the Japanese skill gap between beginners and foreigners fluent in Japanese is the next challenges we should consider. For the

future work, we will design the haptic interaction to help the beginners to supplement inadequate Japanese proficiency with rich haptic interaction.

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