Asynchronous Multi-Party Video Chat System with Reaction

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Abstract: In this study, we developed an asynchronous multi-party video communication system which allows three persons to communicate using video messages. Reaction of the message recipients when they are viewing the video message is recorded and then automatically sent back to the message sender for review so they can sense an emotion response to their message. Our main objective was to evaluates how our system could produce better engagement between conversation party when reaction of recipient shown between message exchange. Our system evaluation using within-subject experiment showed that our proposed multi-party video messaging system with reaction performs better than the non-reaction system as it provides better user experience.

1. Introduction

Asynchronous video messaging provides flexible way for communication since people can create and view messages anytime they want. These especially true when people try to communicate together remotely in different time zone, or they do not have time to communicate synchronously at the same time due to different worktime. However, different from synchronous video communication where communication party could feel the response or reaction from others at the same time, asynchronous video communication is lack of this kind of perk. In this sense, usually a message sender in asynchronous video communication does not know if message recipients really paying attention, understand, or agree when they are viewing the video message. Several studies such as SeeSaw[1] has explored how to add a reaction of message recipient when they are viewing the video message in an asynchronous mobile communication between two persons.

Inspired by the flexibility of asynchronous communication and previous studies, we proposed a prototype of application for multi-party asynchronous video messaging with reaction. Our proposed application enables up to three persons to exchange asynchronous video messages between them. To increase the sense of honesty and emotion between communication party, our system recorded the expression of message recipient when they are viewing the message back to the sender, so the sender can see and review the reaction of recipients from his/her message. In this study we evaluate how our proposed system could produce better user experience between conversation party when the reaction of recipients shown between message exchange.

2. Literature Review

2.1 Emotion Response in Video Communication

One of the perks of synchronous communication such as in face-to-face communication, telephone and real time video conferencing is channel symmetry. This channel symmetry of audiovisual backchannel feedback, e.g., gaze, head nods, smile, laugh and short utterances such as “uh huh,” and “but.” provide cues help in regulate turn taking and minimize misunderstandings between communication party[2]. “Backchannel” is referred to the verbal and nonverbal cues that non-speakers give a speaker during a conversation using non-lexical utterances or body language cues such as shaking head or averting gaze to the speaker. In physical space such as conference where question-and-answer period is limited due to a time constraint, a simple non-verbal backchannel cue in the form of votes to popular questions provides new ways for the audience to interact with panelists, moderators, and other audience members[3].

In digital space, nowadays we see the rise of asynchronous video sharing apps in the mobile space such as Instagram, Vine and Snapchat. While it offers a richer content than traditional text-only or image-only message, asynchronous video communication still lacking such as backchannel feedback which is important in conveying the emotion or response of recipients when they are viewing the message. Efforts to provide these kinds of backchannel in asynchronous communication have been made in previous studies such as Social Camera[4]. Utilizing front camera video re-cording of mobile phone, Social Camera provides an emotion response from people who viewed a photo in photos sharing app. Photos that have received emotion responses are then have special thumbnail attached containing short video clip of the emotion response which can be played by other people. Almost all users think that the emotion responses were personal, meaningful, and connected the photo taker and its viewers.

Another effort in providing backchannel in asynchronous video communication is SeeSaw[1]. SeeSaw is a prototype of asynchronous mobile video chat system, which explored a way to increases user engagement by providing reaction of the recipient when they view the original video message back to the sender. Participants on See-Saw’s experiment found that reaction video created authentic, engaging, and fun conversations without the anxieties of a real-time conversation. In the time-shifted communication context, asynchronous video has been studied to

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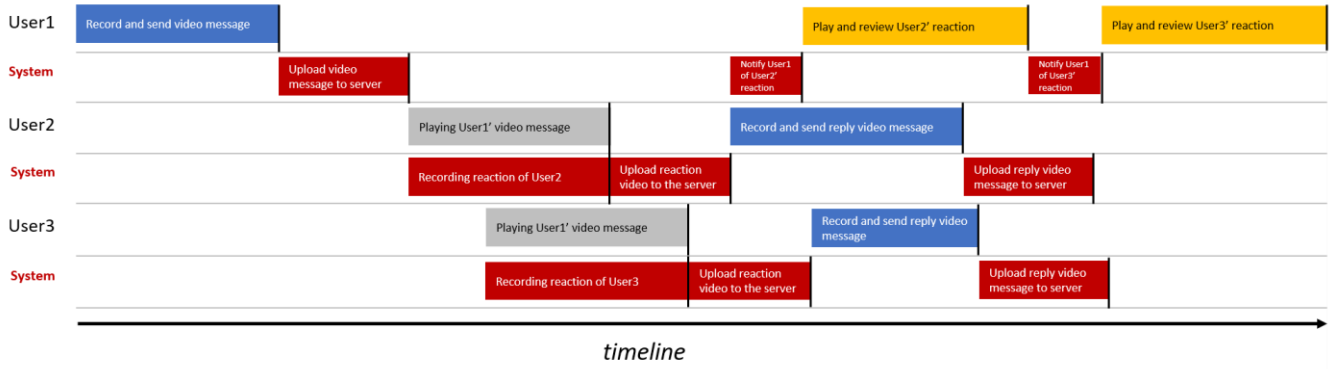

Figure 1. Flow of asynchronous communication between three users in our proposed system

convey sense of co-presence. KIZUNA[5], was developed to enable two people in different time-zone to co-dining together. Pre-recorded session of remote person dining was shown to the other, and to provide sense of co-presence of remote person (in pre-recorded video). While watching the recorded video, the reaction of the viewer was also taken and then played back the next time remote person eat.

Researcher also explored asynchronous photographic and video messaging for children to connect with remote family members. Combining toys and parent smartphone, the Toaster[6] toys captures a self-portrait of children's reaction when playing with it and then send the portrait to parents using e-mail. When the parents received the portrait, they were delighted in their children's happy and silly faces.

Beside conveying emotion through reaction, asynchronous video can also be used generational communication through location-based asynchronous video communication[7]. By combining location information with recorded video of senior family member, telling story occurred at the specific place. These recorded videos then played when family members approach the location of a story, enhance relationships, and create feelings of togetherness over a distance.

2.2 Multi-party Asynchronous Video Communication

Asynchronous video communication can also be used in multi-party communication session when the conversation involves more than two persons. There are already several studies related to this type of communication. Asynchronous video can be used to help temporally distributed teams which are geographically distributed and have large time-zones differences by using implementing thread-based visualization tool to manage asynchronous video conversations such as VideoThreads[8], which implemented a threaded visualization of video messages from all members of team. Following long conversation in linear way require high cognitive load, by using threaded visualization, it can help improve coherence of video messages and reduce the cognitive load of team members. The study found that video can provide opportunities to help teammates gain exposure to each other's personalities and ease complex demonstrations.

Hypermeeting[9] combines synchronous video-conference meeting with asynchronous activity, to help team members in different time zone, who cannot join the synchronous videoconference meeting in reviewing the previous recorded meeting video and adding comments to it. The system implements hypervideo concept and combines it with meeting capture and it enable them to generate and view the hypervideo at the same time. The video from multiple synchronous video-conferencing attendees is recorded and indexed by speaker and topic.

In almost similar vein with Hypermeeting, Time Travel Proxy (TTP) enables people to participate in meetings that they cannot attend in real time, either because of time conflicts or global time zone differences[10]. TTP introduces time traveler concept, where a person pre-records his contribution for the future meeting. The difference with Hypermeeting is that TTP add the meeting participants' reactions to the time traveler's video which is then can be viewed by the time traveler. The design rationale behind adding the reaction on TTP was to capture sense of the meeting members' verbal and non-verbal reactions, such as whether they understood the comment, agreed, or disagreed.

3. Proposal

3.1 System Design

For this study, we are developing a prototype of asynchronous multi-party video messaging system. Our prototype enables participants to send recorded video message asynchronously to the other participants and get the reaction of participants when they are viewing the message. The reaction video of message recipient is recorded automatically and then sent to the other participants for review. The workflow between party in our proposed is illustrated in **Figure 1**. As the reaction video contains backchannel from a video message recipient, we hope it could increase affordance to the sense of emotion, honesty and understanding between communication party as in synchronous video communication.

To increase focus of communication party when they are watching video message and reviewing reaction video, we implemented single message queue system where video message arrived one by one each time. New video message and reaction video will only appear on each communication user feed after previous video message has been played. Study shown that by paying attention to the person talking in asynchronous video communication can shape the conversation, including facilitating turn taking[1]. To communicate using video messages with other in our prototype system, all communication party must be inside

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Figure 2. Screenshots of Asynchronous Multi-Party Video Chat System

same "chat session". This chat session is created by one of the communication party or users who then invites other users into the session.

3.2 Implementation

We built our prototype in three-tier application architecture combined with cloud-based infrastructure. Utilizing HTML5 video recording API allow us to develop the prototype faster, since we are using open standard for the frontend combined with server-side backend written in JavaScript. Since we are developing asynchronous system, we need to store the video messages and reaction videos in file storage which can be accessed through the Internet, and for this prototype we stored the videos in cloud-based storage.

All the other data such as user data and video metadata are stored in lightweight non-relational cloud-based database. For the user interface, we designed the virtual seating position of current active user in this system to be always in the bottom center, while the other users' feeds are placed above it (see **Figure 2**).

3.3 User Experience of The System

There are three phases in one turn of asynchronous video

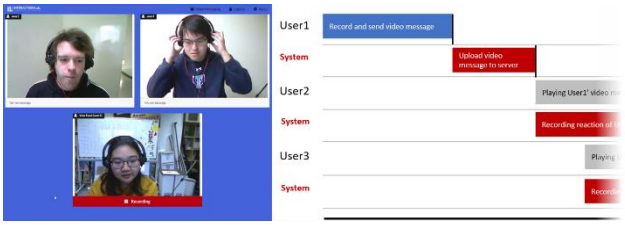

Figure 4. In the Send phase, User1 record and send her video to User2 and User3. After sending the video, User1 then wait for the reaction videos from either User2's and User3's reaction.

conversation within our prototype system. These phases are send, review, and reply in which we explain in detail in the following.

3.3.1 Send

In this phase, user records his/her (User1 in in this example) video messages by pressing the "Start Record" button and when the user done with the recording, press again the "Recording" button (**Figure 3**) to stop the recording. User can preview their video message by pressing "Preview" button, before sending the video to the other users. If he/she satisfied with the video message, then the user can press "Send" but-ton. After the video message successfully saved and sent to the server, the other users/recipients will be notified by the system of the new message.

When the video message arrived and then played by the recipients (User2 and User3 in this case), the system automatically records the recipient reaction within the duration of video message, and after the reaction recording finished, the reaction video is automatically saved and send to the video message server (**Figure 3**). As a visual indicator to help the recipient user know in which the video message is being played and that his/her reaction is being recorded, both sender video feed and recipient's feed are highlighted with purple border. After the reaction video saved to the server, our system notifies original sender of a new reaction video from recipients on his/her

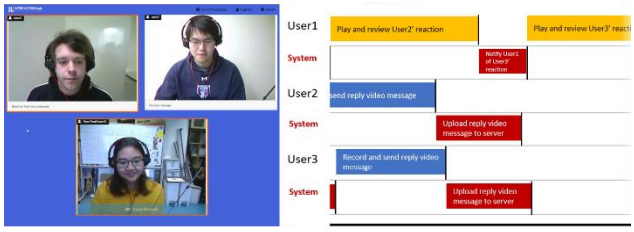

Figure 3. In the Review phase, our system send notification to User1 of new reaction video from User2 and then she reviews User2's reaction video. After finished playing User2's reaction video, User1 got another reaction video from User3 and then review it.

respective video feed, which then can be played for review by the sender.

3.3.2 Review

During this phase, user is reviewing how his/her video message affected the reaction of recipients (**Figure 4**). The reaction video from recipient users are not arrived at the same time since they open the message at different time. At this time, the original message video and reaction video is played at the same time so the sender now at what certain time during the video message the reaction was occurred. To help user sense that the reaction video of her message is being played at the same time with the video

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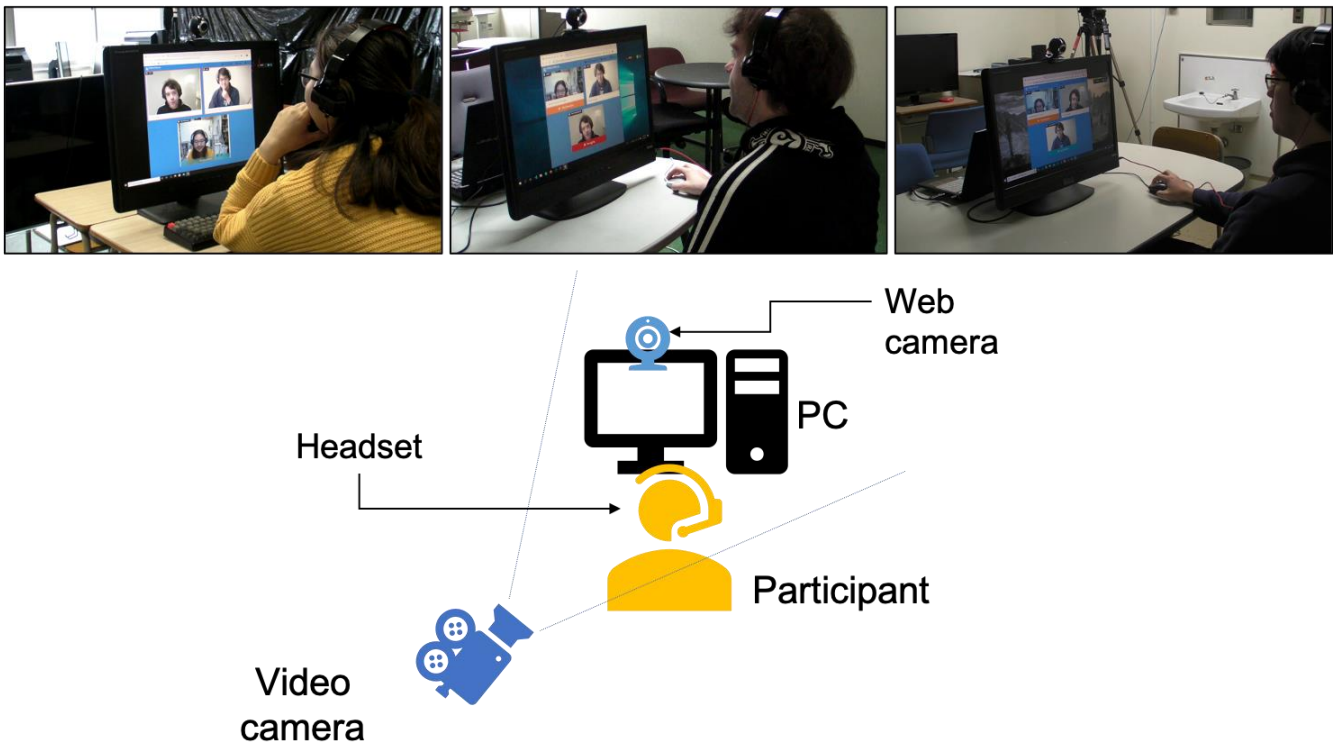

Figure 5. Experiment setup

message, both current user video feed (User1) and recipient's video feed (User2) are highlighted with orange border.

3.3.3 Reply

After received message from other, other communication party (User2 and User3) then can record his/her video message as a Reply. In this example User2 then can start to record his video message and then send it as a reply to User1's previous message. On the other side, after user reviewed the reaction from other recipient users, he/she can wait for reply message from other users and then start another video message and then send it to the other users again.

4. Evaluation

For evaluation purpose we conducted an experiment by inviting participants to use our prototype system. Our purpose of this evaluation is twofold, first we want to measure how our prototype video messaging system with reaction affect the user experience of participants in exchanging video messages, particularly related to how participants could felt the emotion and honesty of their communication party. Secondly, we intended to gather feedbacks from participants based on their experiences when using the system. Before conducting this evaluation, our experiment has been passed an experiment ethical review approval from our university's IRB with ethic number 19-94.

4.1 Experiment Design and Setup

In this experiment we used within- subject design to compare two (2) conditions. In each experiment session, three (3) participants were invited to use our system in both conditions. The two experiment conditions are:

1. **Non-Reaction Condition (NOR).** In this condition we asked the participants to use non-reaction-based video messaging system.
2. **Reaction Condition (REA)**. In this condition we asked the participants to use our reaction-based video message system.

We separated the system with reaction and the non-reaction one into two different system but with same user interface. By separating the system based on experiment conditions, make it easier for us to analysis the videos data and avoid mixed data. For the setup of experiment, we used lab settings where each participant is placed on different room to simulate video communication in different time and places (**Figure 5**).

All participants in this experiment operated a personal computers (PC) with a monitor to communicate with each other. Participant activities such as video message recording and playing incoming videos was controlled only by a mouse without keyboard. Each participant was accompanied with one experimenter in their room. To avoid bias caused by the learning effect on using the system, we counterbalanced the order of condition using Latin-square.

As for our participants, we recruited a total 18 (eighteen) participants divided into 6 (six) groups for this experiment, where each group contains 3 (three) participants. For participants demographic, all our participants are undergraduate and graduate students from our university and come from a diverse ethnicities and countries such as Afghanistan, Ethiopia, Indonesia, Japan, Malawi, Mongolia, Philippines, Thailand, and United States. All participants were given a unique username by us in our system from User1 to User18.

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4.2 Data Analysis & Measurement

For data analysis and measurement in this study, we collected data from various sources. These sources of data are:

4.2.1 Questionnaire/Enquete

At the end of experiment session, we asked participant to rate their experience when using the system by filling enquete. Each question item was rated using five (5) points Likert's scale from Strongly Disagree = 1, to Strongly Agree = 5. Some measurement variables we want to collect are related to participant's feel of engagement, enjoyment, and sense of other participants emotion. We also included measurement of usability and user-friendliness of our system in this enquete. We designed the questionnaire based on modified version from SeeSaw[1] study and user interface's user engagement form[11] (**Table 1**).

Table 1. Questionnaire design

No	Items	Variable Term
	System Usability	
1	I felt lost of time during the conversation with this system	Lost of Time
2	I felt frustrated while using this system	Frustrated
3	It was tedious to communicate with my friend using this system	Tedious
4	Using this system was taxing (need a lot of efforts)	Taxing
5	This system was attractive	Attractive
6	Sharing videos with my friends in this way felt engaging	Engaged
	User Experience	
7	Sharing videos among my friends using this tool felt like a face-to-face conversation	Felt like Face to Face
8	I had a clear sense of my friends' emotion during the conversation	Sense of Emotion
9	I had a good sense of how honest and genuine my friend's replies were to my videos	Sense of Honest
10	I can feel the reactions of my friends to my videos	Felt Reaction
11	I enjoyed communicating with my friend through this system	Enjoyed

4.2.2 Video messages and reactions recording

Participants' video messages and reactions are the primary source of data in our study. For this, we recorded each participant screen with screen recording tool from the beginning of each condition.

4.2.3 Semi structured interview

To gain deeper insight into each participant opinions about our multi-party video messaging system, particularly with the reaction one, we conducted a semi structured interview at the end of experiment session. The interview process was recorded using camera.

4.3 Questionnaire Design.

For our questionnaire, we define 11 (eleven) statements which reflecting participants subjective rating on system usability and user experience. Each of these statement as can be seen on Table 1 are represented by their variable terms: 1) Lost of Time, 2) Frustrated, 3) Tedious, 4) Taxing, 5) Attractive, 6) Engaged, 7) Felt like Face to Face, 8) Sense of Emotion, 9) Sense of Honest, 10) Felt Reaction, and 11) Enjoyed.

4.4 Experiment Procedure

At the beginning of the experiment session, participants will be given a written and verbal consent form and an explanation about the experiment. Participants are then asked if they agreed to the experiment condition and then given a consent form. One participant was assigned as a conversation starter and the send first video message. To make the communication between participants more enjoyable and more natural, in this experiment we did not restrict the topic of conversation. We gave all participants freedom to talk anything and to change the topic in the middle of communication flow and also did not give time limit for the recording duration of video message. All participants were given explanation on how to use the video messaging system and short trial on the system.

Each participant was guided by one experimenter to their own experiment room and accompanied by the experimenter in experiment session. Camera recording started as soon as the experiment started, from the time the conversation starter starts using the system. For this experiment, we asked the participants to do a turn taking in sending video messages. Participants need to wait for another users' video message before sending another video message. Our consideration in using turn-taking was to reduce one-person dominance over communication flow and also to avoid mingled communication flow. We anticipated there will be drawbacks with this procedure. Firstly, by employing turn taking we limit participants freedom in exchanging video messages as they need to wait for other replies before making new video message. Secondly, there will be longer delay between messages exchange and this can also inflict boredom to participants especially in REA condition where participants also need to review reaction video.

At the end of experiment session, each participant was interviewed by the experimenter on each room. We limit the time of conversation for each condition to 20 minutes and after the time limit has been passed, we will ask the participants to stop their conversation. Questionnaire form then given to each participant to be filled.

5. Evaluation Result

In this section we present the result of our experiment based on

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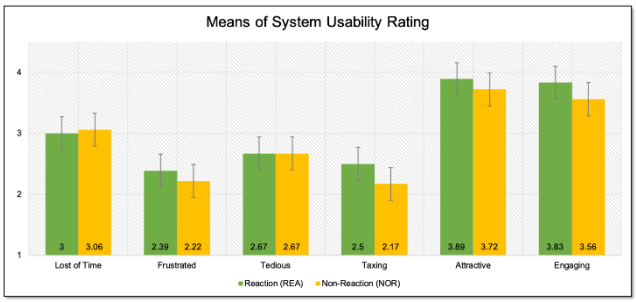

Figure 7. System usability ratings

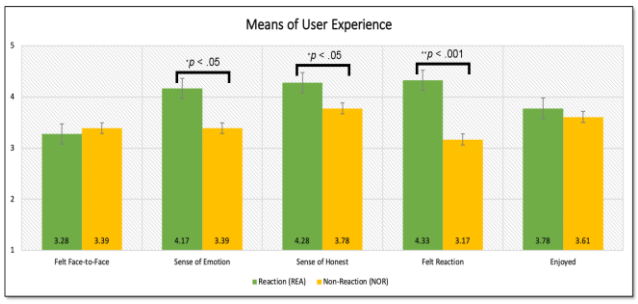

Figure 6. User experience ratings

our data analysis from our questionnaires result.

5.1 System Usability

First, we want to report the result on the system usability side which are represented by 6 (six) variables: Lost of Time, Frustrated, Tedious, Taxing, Attractive, and Engaged. As can be seen on **Figure 6** presents comparison between each variable of system usability rating. Using SPSS, we then measured statistical comparison using paired sample t-test for each variable. For the Lost of Time variable, the result from REA condition (M = 3.00, SD = 1.23) and NOR condition (M=3.05, SD=1.05) reported insignificant difference, $t(17) = .18$, $p > .05$. In the Frustrated variable, the result from REA (M = 2.38, SD = 1.03) and NOR (M=2.22, SD=.87) reported insignificant difference, $t(17) = .64$, $p > .05$. In the Tedious variable, the result from REA (M = 2.66, SD = 1.02) and NOR (M = 2.66, SD = .97) also showed insignificant difference, $t(17) = 0$, $p > .05$.

The Taxing variable reported insignificant difference with REA (M = 2.5, SD = 1.2) and NOR (M = 2.17, SD = .92), $t(17) = 1.24$, $p > .05$. On the Attractive variable of the system, the REA (M = 3.89, SD = .9) reported no significant difference from the NOR (M = 3.72, SD = .75), $t(17) = 0.9$, $p > .05$. The last variable from the system usability is the Engaging variable which the REA condition (M = 3.83, SD = 1.04) was also re-ported insignificant difference than the NOR condition (M = 3.56, SD = .92), $t(17) = 0.92$, $p > .05$.

Based on two-tailed paired sample test we have presented before; we can see that all the system usability's variables rating reported insignificant difference between the REA condition and NOR condition. We want to emphasize more on the Taxing variable, as we already mentioned before that there is insignificant difference between the REA and the NOR condition. From our current observation to participants' behavior in the experiment and also confirmed by our participants' comment on the interview, the process of reviewing reaction videos was more taxing than just watching normal video message. The cause for this was that in REA condition, participants need to review reaction videos from two other participants, while in the NOR condition they do not have to review any reactions. We can imply from this, that even though reviewing two reaction videos was more taxing effort, participants felt no problem with it.

5.2 User Experience

The user experience of participants was rated in 5 (five) questionnaire's variables: Felt like Face to Face, Sense of Emotion, Sense of Honest, Felt Reaction, and Enjoyed. **Figure 7** provides an overview of comparison between conditions on those variables. Result from 2-tailed paired sample t-test reported that the NOR condition (M = 3.39, SD = 1.14) has no significant difference than the REA condition (M = 3.28, SD = 1.07) with $t(17) = .35$, $p > .05$ in Felt like Face to Face variable, which mean that both reaction and non-reaction system produced same feeling of face to face communication.

In the second variable, Sense of Emotion, our reaction video messaging system have significant effect on how participants can sense the emotion of others compared to the non-reaction video messaging system. The REA condition (M = 4.17, SD = .85) are significantly rated higher than the NOR condition (M = 3.39, SD = .97), $t(17) = 3.75$, $p = .002$. We saw similar result on the third variable, Sense of Honesty, where The REA condition (M = 4.28, SD = .66) are significantly rated higher than the NOR condition (M = 3.78, SD = 1.0), $t(17) = 2.15$, $p = .046$. Result in this variable indicated that our proposed reaction video messaging system could make most of the participants to get the sense of honesty from their communication counterparts when viewing the video messages.

Our intention to design asynchronous multi-party video with reaction is to make communication party can feel the reaction of others and then increase the participants engagement and experience. Our result from the Felt Reaction variable are in line with our expectation that participants can clearly felt the reaction of others when they viewed the message as it is reported a significant difference between the REA (M = 4.33, SD = .59) and NOR (M = 3.17, SD = 1.09), $t(17) = 5.02$, $p < .001$. On the last variable related to enjoyment of participants when using the system, the REA condition (M = 3.78, SD = .94) was reported had no significant effect than the NOR condition (M = 3.61, SD = .85), $t(17) = .718$, $p > .05$.

6. Discussion and Conclusion

Result from the system usability side showed that the non-reaction asynchronous video messaging system has similar rating with our proposed asynchronous video messaging with reaction system. However, data from our interview with participants revealed more insight about participants' opinion on the reaction system, particularly related to the efforts on reviewing reaction videos from others. One of our participants, User7 felt that even though the process of reviewing reaction videos is some-times tedious to do as she needs to watches two reaction videos from others while her video message played playing at the same time, it is still more fun than just waiting for other messages in non-

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reaction system. We also observed that User7 cannot wait for the reaction video from the other and then play the reaction videos even though it was already passed the 20 minutes experiment time limit.

> *"... yea it is more interesting than in the first system (the reaction system), I think it is more tedious, more time consuming in the first one (the reaction system), more efforts focus, it is nice to see the reaction of the people, but I don't like I keep hearing my voices again and again (the reviewing process)... but I still prefer the first one, because in the second one (the non-reaction system), it just like a... like texting..."* – User7

The statement from User7 about the reaction video is in line with previous study which stated that the reaction video provides a sense of attention that generates a feel of an asynchronous conversation, rather than exchanging messages in conventional video messaging systems[1]. Other participants, User11 also expressed the same opinion with User7 about how tedious to review reaction videos. While he preferred the non-reaction system over the reaction system, he still felt that the reaction videos were still good because it enables you to know how other people interested in your message or not.

> "*... of course, the reaction is good, because (from) the facial expression can tell whether someone is more interested in your message or not, but the drawback is it is takes time ehh, ... because you listen to their response (reaction)... but I ... I know it is good (the reaction) ...*" – User11

These tedious and taxing efforts of reviewing reaction videos in multi-party asynchronous video communication are we think the challenges that can be investigated further in future study and still not explored in previous studies on video communication with reaction. What kind of effective strategies that can be applied to reduce the taxing and tedious effort in reviewing reaction from more than one person while at the same time a communication party can still capture the sense of honesty in multi-party communication? Earlier we also mentioned about our design to increase focus of communication party in watching video message and reviewing reaction by applying single message queue, in the future study we also want to investigate the effect if we allow multiple number of incoming message and reaction.

Previous studies have explored how asynchronous video communication helps people to communicate even on different time zone and how watching reaction from another person when watching our message is important to recognize the emotion of them. Inspired by those studies we developed our prototype asynchronous multi-party video messaging system with reaction to enable people to exchange video messages in asynchronous way for up to three persons. For our system evaluation purpose, we compared between the non-reaction condition and reaction condition. Result from the evaluation showed that our proposed video messaging system with reaction provides better user experience, as it makes them can sense emotion, hones-ty and felt reaction significantly better than the non-reaction system.

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