

Social Essence: Low-Threshold Social Presence in Remote Collaboration

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INTRODUCTION

As more and more people work from home, work has become more globalized and technological advancements have facilitated this change, working remotely has become increasingly common. According to WFH Research [2], in 2022 almost 30% of full worked days in the US were from home. Microsoft's New Future of Work Report 2022 [21] almost exclusively focuses on hybrid work. This increase in interest in remote work makes the topic of remote collaboration more relevant than ever before. Team collaboration is one of the main overarching topics that Microsoft discusses in the Future of Work report. When designing for remote collaboration, it is important to consider how designs support communication between users. This is called computer-mediated communication (CMC). Although there has been much research about this design topic and many interesting designs have been proposed, only little of the designs proposed in research have made it to consumer products. This is due to bottlenecks in the sales process and a disconnect between user needs and the proposed designs. The research question for this project is: how to design for low-threshold social presence in remote collaboration?

One way to achieve better communication is through social presence. Although there is no universally agreed definition, the most common one is: perceiving other people that you are (collaborating online) with as 'real' and understanding their thoughts [17]. Biocca describes it the following way [3]: "The minimum level of social

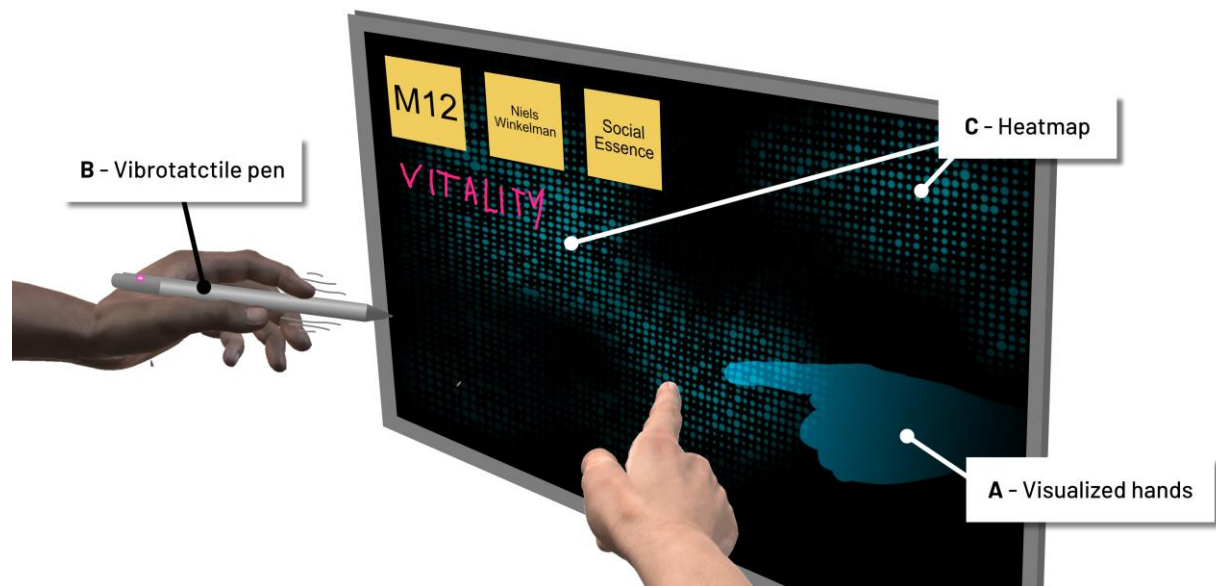


Figure 1: The three designs that resulted from this project. (A) Motion captured hands are visualized from remote collaborators, (B) a vibrotactile pen vibrates when someone joins or two cursors come close and (C) a heatmap that shows where two different people have both been.

presence occurs when users feel that a form, behavior, or sensory experience indicates the presence of another intelligence. The amount of social presence is the degree to which a user feels access to the intelligence, intentions, and sensory impressions of another." Although social presence can be both considered for human and robot

actors, in the context of communication and collaboration, it will be exclusively used for interhuman interaction. The word 'real' causes some ambiguity about social presence. You could measure 'realness' as being how realistic the human actor is represented. This is called photographic or anthropomorphic realism.

However, in the context of this research, it is considered as the measure of how real the human actor feels to the perceiver and therefore how well the perceiver can see what the human actor thinks, feels, and does. This is called behavioral realism. For example, a simple visualization that can better convey the thoughts, feelings, and activities of a human, by this definition has more social presence than a more realistic version that cannot convey that well.

Designs with different social presence representations can be described using social translucence [6]. Social translucence can be defined as how and to which extent we make our activities visible to each other. This can be interpreted as the act of finding a middle ground in this visibility. Social translucence is about finding which things to make (in)visible and assessing the tradeoff between things like visibility and privacy. Erickson and Kelly classify three approaches on how social information can be represented. These are the realistic, mimetic, and abstract way. ‘Realistic’ tries to directly replicate the real world as accurately as possible, ‘mimetic’ tries to replicate social cues in a digital way, and ‘abstract’ tries to replicate information through a medium which is not similar to the original information.

RELATED WORK

Many interesting and advanced collaborative work systems have been proposed in literature over the last 30 years. Early in the 90s, the first designs were introduced that combined whiteboarding/drawing applications with video conferencing [12,20]. Later, research split up into either making these designs more advanced and realistic [11,13,15,16,18,19] by for example enabling eye-contact [14] or thinking about other ways to represent the users [8,10]. More recently, designs like the dBoard, a “virtual window” for scrum, [7] and 3D-Board, a whiteboard that overlays a cutout of humans in video, [23] have consolidated earlier research and new technologies into promising concepts. More recently, eye-contact has been further researched by Nvidia [5].

In a systematic review of social presence [17], Oh et al. have already contextualized the design space and established and reviewed factors that influence social presence. Important factors for this research are visualization, interactivity, haptic feedback, depth cues, audio, proximity and identity cues. The authors found that more behavioral realism increases social presence. Specifically considering visualization, behavioral realism is more important than photographic or anthropomorphic realism. In addition, the authors found that more/better visualizations, interactivity, haptic feedback, audio and identity cues are positively associated with social presence.

UNDERSTANDING THE DESIGN SPACE

The first goal of this research was to find out why so little social presence designs had made it to consumer products. Although we have seen much research into social presence, none of the proposed literature designs like dBoard, 3D-Board and CollaBoard [7,15,23] have made it to consumer products.

In an interview with a product designer from CTOUCH, a company that makes interactive touchscreens, it was found that the company is actively developing these kinds of designs. However, the interview identified two reasons why these features have not made it to products.

Intermediate parties

First, there are many intermediate parties between the designers and the end-users of these products who prevent features from making it to users. All these intermediate parties have their own goals, procedures, and resources which influence the final product. Intermediate parties could be manufacturers, resellers, tender facilitators, and the purchasing company of the users. Resellers might want to increase security while saving on development costs and therefore disable these features. The IT department of a buying company with limited resources might choose to disable these advanced functions so nothing can break. Purchasing companies think that having interactive displays with these features on their network is a security risk.

The first solution to the intermediate parties problem is to convince the purchasing companies that these features are worth the development costs and security risk. This way, intermediate parties will be more likely to preserve these features. The second solution is to make features more inherent to the system, easier to implement and a lower perceived security risk.

Low threshold collaboration

Secondly, when users enter a collaboration with someone, they want the whiteboarding to be extremely low threshold and to work immediately. Users want standard and simple whiteboarding features and will not try, enable, and learn advanced features. This problem is exaggerated because most collaborative whiteboarding happens on shared devices. On shared devices, users are even less likely to learn new features because they do not own the device.

Discussing preliminary designs

The expert was shown two designs to start a discussion about different aspects of design for social presence. The first prototype (Figure 2) is a presentation tool which allows presenters to physically move through the depth of their presentation elements. This was based on the idea of proxemics [9]. The representations of the humans featured different levels of realism/abstraction. The second prototype (Figure 3) visualizes the hands of remote collaborators in a mimetic way. As the hands move away from the screen they blend into the background. When the index finger is extended, it creates a particle trail.

The expert was not convinced of the first prototype and thought that it would be in the way of the content. Additionally, the expert noted that a presentation is often being led by one person that is mostly the focus and this prototype does not consider that. The expert thought that the second prototype was more interesting. The expert liked that the prototype looks abstract, not like a real hand and that the trails do not look computer-like. They also liked that the visuals do not get in the way of the content and are only there when you need them. According to the

expert, it gives you the idea that you are thinking together. The expert was skeptical about possible lag and the earlier described intermediate parties problem. Additionally, the randomness of devices and workflows of people might make this design only appealing and usable to few users. When discussing the temporal nature of the trails, the expert pointed out that ‘whiteboards are podiums for your work’ and that you want to focus on the results and not on the way you got there.

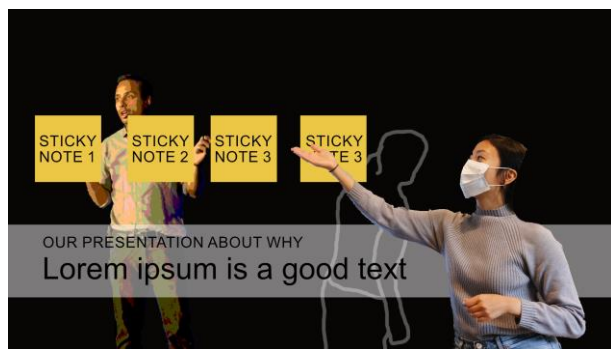


Figure 2: Prototype for presenting using depth and different levels of abstraction/realism.

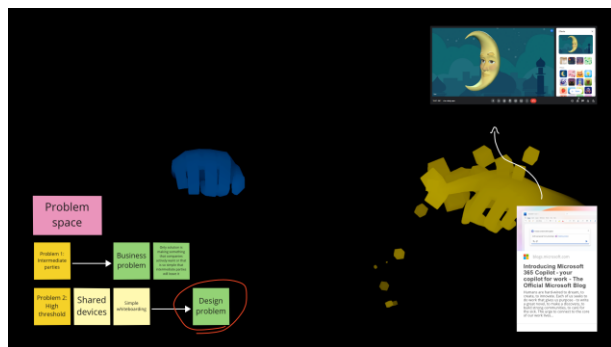


Figure 3: Mimetic hand prototype using depth and trails.

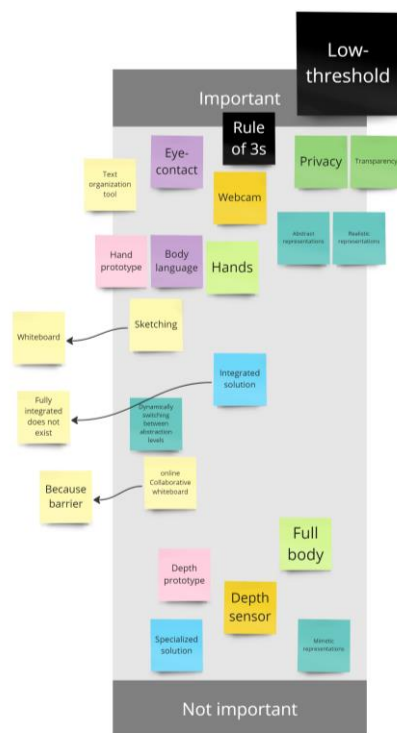


Figure 4: Expert importance ranking of concepts.

Design implications

Considering that intermediate parties in the sales process tend to remove advanced features and that users rarely want to use them, design might need to move towards being lower threshold. For users, this means that the designs should be immediately usable and easy to learn. On the company side, this means that designs should be technologically simple to implement and not a security/privacy risk. It was chosen not to focus on the business side of the previously mentioned problems and only on the way design could help solve them.

To achieve this low-threshold, we might look towards the idea of social translucence [6]. This is the consideration on what information of users is made (in)visible to others. As described earlier, it could be considered the act of

making the tradeoff between visibility and privacy. In this context specifically, the literature designs [7,15,23] show as much information as possible through a video image in a photorealistic way. It is now the goal to find and get rid of information that is unnecessary and make a design with only the information that is relevant.

While existing designs focus mostly on photographic and anthropomorphic realism, Oh et al. find that design might benefit from showing behavioral realism [17]. So instead of showing a video image in online collaboration, we might question what makes the video image relevant to the users and try to only represent that in a lower-threshold way. As discussed earlier, Erickson and Kellogg classify three approaches on how social information can be represented [6]. These are the realistic, mimetic and abstract way. The authors argue for mimetic and especially abstract approaches which also try to distill information to become more relevant.

When applying these ideas to the hand prototype shown in Figure 3, it becomes clear how this theory works. Instead of showing an entire video, we identify that hand movements are relevant behavior of the user and reveal no sensitive information. We represent this information by showing motion captured 3D rendered hands that mimic real hands. This introduces other benefits like using less internet bandwidth.

At this point, a preliminary list of factors can already be drawn up that are important for low-threshold social presence design in remote collaboration. The factors will be later explained in more detail. The factors are threshold, abstraction<>realism, privacy, integration, interactivity, physicalization and temporality.

Reframing the research

In the first design iteration, the question was answered of why existing social presence designs are not yet integrated into consumer products. Answering this problem marks the start of the second iteration. This iteration poses the following research question: How to minimize threshold in social presence designs for online

collaborative whiteboards? The answer to this can be made more concrete by the following sub-question: What are the key factors influencing the effectiveness of minimum-threshold social presence in online collaborative whiteboard design?

In the research through design approach, knowledge can be created by designing and evaluating those designs. The first step of this process is to diverge and create new designs with the direction that was just established. To generate new ideas, a co-creation session with design students is planned. The goal of this session is to come up with as many diverse ideas as possible within the constraints that the ideas should be low-threshold and focus on behavioral realism. After this, the goal is to become more concrete and evaluate these ideas. This will be done through an evaluation session with the experts. The focus will be on comparing and evaluating the concepts made by the students. Finally, based on the expert session, the best designs will be worked out by the researcher in higher fidelity. These designs will be tested with users to verify insights from the expert co-creation and draw final conclusions.

STUDENT CO-CREATION

The main goal of the co-creation session with students was to generate many new ideas. Additionally, a side goal was to see how the participants can use the list of factors described earlier to evaluate the design and add to and finetune the list. The focus was not on working out these ideas or drawing extensive conclusions.

The researcher assumes that students will be able to come up with more creative ideas than industry experts because of their lack of industry experience. Moreover, it is easier to gather a diverse group of students with different expertise and perspectives in the same session. The downside of students is that their lack of experience will reduce the validity of the ideas. However, validity is not the goal of this session and will be more important during the expert evaluation.

2-3 students will participate in each session. Students will be recruited so that each session has students with diverse expertise, which is relevant to the research topic.

The first part of the session will be an ideation session that uses methods like brainwriting and braindrawing to ideate and methods like SCAMPER [4] to iterate. In the first rounds, the students will be tasked to work together to come up with ideas for social presence in remote collaboration design. Halfway through the ideation, the students are introduced to the criteria of low-threshold and behavioral realism. The criteria are only introduced halfway to initially preserve creativity. If the students get stuck, they will be presented with different keywords that are relevant to this design space.

After this, the students will be asked to compare and rank the ideas that they created and explain why using the factors preliminary factors described earlier. The students will be asked to perform a vALUE analysis [4] on the best ideas. This means that they write down the advantages, disadvantages, and unique aspects of each idea based on the list of factors.

Co-creation results

Some improvements were made after the first session. During the second session, participants were given different color pens for different iterations to easily track the iterations. In the second session, the participants were more explicitly told to use the given factors to rate their ideas, which helped them to become more concrete.

After the brainstorming session, the researcher instructed the participants to pick their best ideas. These ideas were named and rated.

The participants in the first sessions did not use the factors to analyze their designs. As a result, the analysis of the designs was not constructive and did not say a lot about how the designs influenced social presence. To prevent it from happening again, usage of the factors was explicitly encouraged in the second session. Additionally, the factors were better explained to the participants. As a

result, analysis and discussion was more focused on social presence and more constructive.

Analyzing ideas

Next, both previous and co-creation ideas are analyzed by the researcher. The goal for this analysis was to choose the best ideas, work them out, prototype them, and discuss them during the expert evaluation and demoday. Furthermore, during the analysis, it became clear that the act of analyzing ideas using the preliminary factors was a great way to flesh out and improve this list towards a final list of key factors. First, the creation final list will be discussed. Thereafter, the choice of designs is explained using this list.

Table 1: Best ideas generated by the participants
Live mood representation (s1) The design shows a mimetic representation of the eyes of the remote user. According to the participants, eyes can represent mood well and therefore the visuals should reflect the remote user's mood. Additionally, the location of the eyes might show where the remote user is looking.
Directional sound (s1) A direction sound system that has a clear stereo/directional sound image of where remote collaborators are standing.
Haptic communication (s1) A haptic pencil to indicate presence of remote collaborator. The participants also suggested that the vibration could be in the board and more location specific. Participants discussed gestures like knocking to get attention.
Teleporting device (s2) Initially, the participants came up with a teleporting device that could teleport objects to a remote collaborator. Later this idea was made into a scanner that could scan and send things like objects and sketches live to remote collaborators. Participants said it was like a 'real life snipping tool'.
People on screens (s2) In a physical meeting room, there are multiple screens with their own cameras in some places where chairs would normally be. Remote collaborators can claim one of those screens. If multiple screens are available, a participant can switch between screens and therefore also their camera.

Figure 5: Idea selection using the key factors. Green, orange, and red sticky notes give some idea about judgement that is given based on the result while white sticky notes are just an observation without direct judgement and only matter in the context.

		Input	Output	Realism/abstr action	Realism type	Pairing strength	Relevance	Obstruction/distraction/impairment	Threshold	Privacy	Control	Who	Synchronicity	Regularity
Gaze visualization		Gaze	On screen	Somewhat abstract	Behavioral	Direct	Behavior not always relevant	Highly obstructive	Medium threshold	Not inherent	Can be made private	Little control	Happens in the moment	Happens most of the time Can we fix this?
Vibratile pen		Pickup	Haptic	Abstract	Behavioral	Complete	A little relevant	Lowly obstructive	Low threshold	Very private	Control	Both users	Happens in the moment	Only when you need it
Hands		Hands	On screen	Realistic	Behavioral	Direct	Relevant	Lowly obstructive	Low threshold	Private	Control	Both users	Happens in the moment	Only when you need it
Depth presentation		Full body	On screen	Realistic	Behavioral	Direct	Relevant	Highly obstructive	Medium threshold	Not private	A little control	Both users	Happens in the moment	Happens most of the time
3D-board		Full body	On screen	Realistic	Behavioral	Enhance	Relevant	Highly obstructive	High threshold	Not private	Little control	Both users	Happens in the moment	Happens most of the time
dBoard		Full body	On screen	Realistic	Behavioral	Enhance	Relevant	Obstruction	High threshold	Disruptive	Little control	Both users	Happens in the moment	Happens most of the time
People on screens		Upper body	On extra screen	Realistic	Behavioral	Enhance	Not relevant to the task	No obstruction	High threshold	Disruptive	Little control	Both users	Happens in the moment	Happens most of the time

Analyzing ideas

Each idea was analyzed based on the list of factors in a similar fashion to a weighted objectives method [4] (Figure 5). While filling out the table, the researcher would wonder why inconsistencies or inaccuracies occurred in the ranking. This then resulted in tuning or adding key factors.

For example, gaze visualization and hand visualization were very similar according to the current factors. The assumption that gaze visualization was less desirable led to adding a new factor called ‘control’. With an eye-tracker, the user has almost no control yet while using hand pose tracking, the user actively and with intent controls it.

During this analysis, earlier designs from the project and literature designs like dBoard [7] and 3D-Board [23] were also added to the table for the sake of diversity. Table 2 shows the final list of key factors.

Idea selection

The visualized motion captured hands and haptic communication ideas were selected to be worked out further. Both ideas scored great on the rating using the

key factors. The live mood representation did not score well because the user misses some control, it also happens when the user does not desire it (regularity) and privacy is not inherent. The directional sound and people on screens idea were dropped because they are not relevant to the whiteboarding element of the research. Finally, the teleworking device was not selected because it had a very weak connection with social presence.

Table 2: List of key factors

Realism/abstraction
How much does the representation directly resemble the actor or their actions? [6]
This is closely tied to the interaction frogger’s idea of inherent, functional and augmented feedback [1].
Realism type
What type of realism are you representing? [17]
- Photographic - Anthropomorphic - Behavioral

Pairing strength
How well does the representation present what it intends to represent? How direct is the pairing? How well can the user understand the pairing?
Relevance
Is the representation relevant to the user? How relevant is this to the task? Is the element of a human you a representing relevant?
Privacy
How much of the user’s sensitive information does the system reveal? Is the privacy inherent or is it based on the implementation?
Regularity
Is it only there when you want it or when it is relevant? Is the representation constantly there or does it only appear when something happens?
Synchronicity [22]
Does the representation exist over time or only in the moment?
Threshold
How much effort does it take to (start) using the feature/design?
This factor is directly linked to almost all other factors.
Control
Can the users control the representation
Obstruction/distraction
Does the representation obstruct or distract from the content?
Who?
Who benefits from this feature? Who is affected? Are both the user and remote collaborator benefiting?

EXPERT EVALUATION

The goal of the expert evaluation was to get feedback about the worked-out designs and to improve the list of key factors. Because an overarching goal of this project is to understand how to conceive a social presence design that will could it to consumers, it is relevant to discuss the validity of the ideas with an industry expert.

Designs

The two ideas that were worked out are the visualized hands and the vibrotactile pen.

The design of the visualized hands stayed similar to previous iteration. The main feature of this design is the motion captured hands that are visualized using a shader that shows depth. A trail was included that could be triggered by extending the index finger (Figure 7). Finally, based on the experts previous feedback on collaborating with many people, a set of icons was added that could replace the visualized hands (Figure 8). These icons are still rendered using a depth shader.



Figure 6: Interaction with motion captured hands



Figure 7: 3D visualized motion captured hands

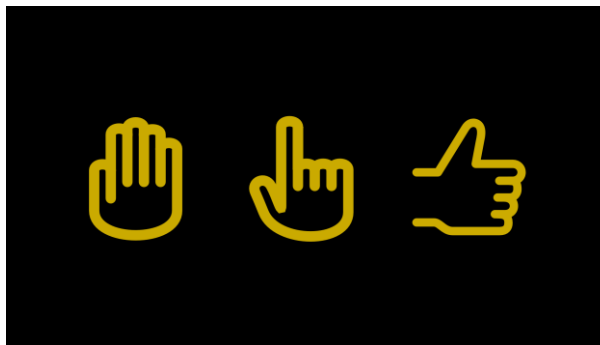


Figure 8: Icons representing motion captured hands

The vibrotactile pen should vibrate and detect when it is picked up. The pen was 3D-printed to fit a vibration motor. An aluminium sheet was stuck to the outside of the 3D-print to act as a capacitive sensor. Due to the pen being plastic, it could not act as an touch pen for touchscreens.

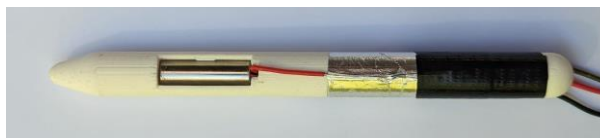


Figure 9: Vibrotactile pen

Method

A method was established for discussing the designs and evaluating the key factors. Unfortunately, more important matters prevented the full execution of this method during the session. Specifically, this meant that there was no discussion on the key factors. Fortunately, the designs were still discussed, albeit in a more informal fashion. Colleagues of the expert joined the discussion which disallowed the use of the audio recording from that moment on.

Results

The expert interview highlights some important discussion about the designs. The overarching finding was that the experts preferred the visualized hands over the vibrotactile pen. They found that the vibration in most cases is not that relevant. For them, this did not weigh up to the price and inconvenience of making a vibrotactile pen. However, they did like the idea that it was detected when the pen is picked up and the visual 'pulse' on the screen that represented this because this did not require building a smart, battery powered pen. The expert liked the 3D visualized hands, the option for icons that represent common gestures and the pointer trails that could be created. This preference was confirmed by the expert eagerness to show off and pitch the hands design to their colleagues while somewhat disregarding the vibrotactile pen.

Conclusion

It was decided to keep both designs and fully work them out for the demoday. The vibrotactile pen was kept because the main concern was the market feasibility, which can be kept in mind, but does not influence this research project.

DEMODOY

The demoday serves as a good moment to gather feedback and data. First, improvements to the prototypes will be explained whereafter the feedback and data collection will be elaborated.

Prototype improvements

As preparation for the demoday, the vibrotactile pen was improved and a heatmap design was added as a new social presence feature.

To give the vibrotactile pen touch capabilities and make it nicer overall, the tip of a capacitive touchscreen stylus was put on an aluminum tube. This tube both provided touch capabilities and acted as a pickup sensor while being able to hold the vibration motor.



Figure 10: Redesigned vibrotactile pen

The introduction of a heatmap emerged from an earlier design exploration that was about visualizing where the motion captured hands' past locations. Initially, the idea did not have much merit because it only visualized one user. However, its value became apparent after finding that it could display a heatmap that combines data from multiple remote collaborators. Specifically, the heatmap was a multiplication of heatmaps of different collaborators, meaning that it only emerged when two users had been on the same location.

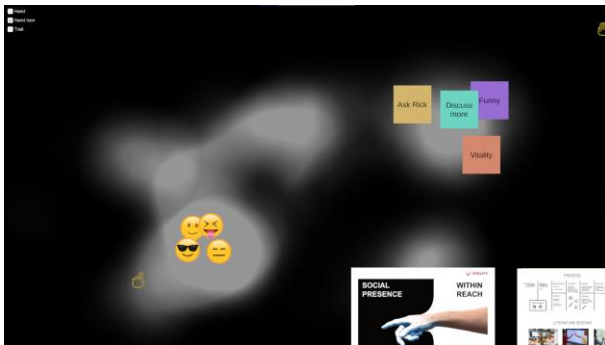


Figure 11: A heatmap which only emerges when two users have been on the same spot.

Data collection

The researcher prepared a lo-fi survey to find which designs are best received by the demoday crowd (Figure 12). The survey shows the 3 main social presence designs. Visitors can score which design they liked most and explain why.

Example	Score	IT looks good!
visualized hands		- very clearly, easy to understand - not busy, to understand - feels like someone is present
Hand icons		- minute, self-explanatory and universal - provides with many people - good balance
Haptic pen		- both with sense, movement of people
HEATMAP		- filtering different people - also self-explanatory, no need to explain - also universal, easy to understand - also universal, no need to explain - also universal, no need to explain - also universal, no need to explain

Figure 12: Demoday survey about prototypes

Results and feedback

Interestingly, the heatmap tied with the visualized/icon hands. People found the heatmap interesting because it allowed for filtering between different people and seeing what you worked on with different people. They found that it required little explanation and that it was universal. The heatmap could be useful for collaborative reflection moments.

The visualized hands were also well received. The consensus was that they would work best when dynamically switched from 3D visualized hands to hand icons as more people joined the collaboration. The image is too chaotic with more than two 3D visualized hands. A visitor commented that the 3D visualized “hands are emotional, clear evidence of contact (with a remote person)” and someone else commented that it “feels like

someone is present”. These comments hint that social presence is stimulated by the 3D visualized hands. Visitors found that the hand icons might require less coordination and permission seeking with others.

The vibrotactile pen received no votes. One reason might be that it did not fully work at some times. More likely, the design was not well received. Reconsidering the key factor analysis, it did not score well on relevance. Although the pairing strength was good, maybe it was not clear because the representation is too abstract. It seems that abstract designs do not work when the pairing is unclear.

USER TEST

At the end of this research, a user test was planned. The first goal of this study was to test whether the proposed designs increased social presence and could successfully be used by participants as a remote collaboration tool. The second goal of this study was to test whether the proposed key factors can be used as questions to test the validity of a social presence design. The initial plan was to include all prototypes (hands, pen and heatmap) in the user test. However, it was determined that this introduced too many variables to draw any meaningful conclusion about the social presence of each design and the questionnaire of key factors. Therefore, only the visualized hands were tested as they should immediately increase social presence compared to the heatmap.

Method

Two students remotely collaborate on a simple whiteboard. The participants will try to recreate an image (example in Figure 13) using the whiteboarding software. Participant A (explaining role) sees the desired image and tries to explain to participant B what it should look like. Participant B (whiteboarding role) will try to recreate this image using the whiteboard software. First, the explaining participant can only use voice to explain the image and later, they will additionally use the visualized hands prototype. This was chosen, because in the average whiteboard, users cannot use touching/clicking to point to items. To diversify the tasks, each image will require the

whiteboarding participant to arrange items on the screen as well as draw.

A questionnaire was constructed that the participants would fill in after finishing a role. This questionnaire can be found in the Appendix A. The questionnaire is a combination of the Computer Mediated Communication Questionnaire (CMCQ) [22] and questions constructed based on the key factors. Afterwards the participants are interviewed.

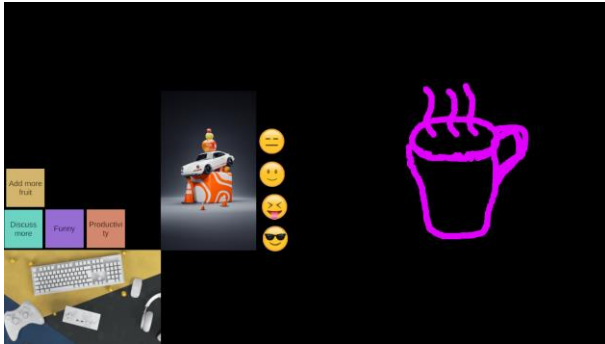


Figure 13: Image that the participants needed to recreate.

Results

The study was executed 2 times with 2 participants.

Because the setup of the user test changed between the tests, It was not possible to draw any meaningful conclusions based on the questionnaire.

During the interview, two participants said that this design increased their feeling of being with a ‘real’ person. One participant said depends on the performer, and you can “express personality”. One participant said that it did not increase. In terms of usefulness, participants said that it increased their efficiency, and it was mentioned that it is the same as a mouse cursor (keep in mind that most touchscreen applications do not have full cursor capabilities).

DISCUSSION

User test

The first user test took place in a setting where two participants were placed in two meeting rooms next to each other. This was done so both participants could be in the explaining role once. During the interview, it was found that seeing each other before the user test heavily influenced their perception of social presence. Therefore, the second user test was carried out while one person joined in with a video call. Due to the difference of the user tests, it is difficult to draw conclusion from the data.

Additionally, the testing method was not thought out well enough which made it difficult to draw conclusions from the questionnaire. Additionally, the key factors questionnaire was too focused on the task effectiveness compared to social presence when leaving out the CMC questionnaire.

Key factors

The final list of key factors proves to be useful when designing for low-threshold social presence. However, it might not work well in a questionnaire format as it asks not questions about social presence itself but more about the factors around it. The list is not properly validated, and some factors might be more influential than others. The list of factors and how they influence low-threshold social presence design are discussed below. Factors with already established judgments to them like relevance, obstruction/distraction, threshold, privacy and who are excluded from discussion.

In terms of realism/abstraction, realism does not work well for low-threshold social presence design. Too abstract representations may not work well when the pairing is not very clear (vibrotactile pen). However, when clear, like in the heatmap design, it can work well. Mimetic representations have less chance of failure as they represent something inherently real and might have the best balance on the social translucence scale for social presence.

The project confirms that behavioral realism is indeed the most relevant type of realism in low-threshold social presence design compared to anthropomorphic and photographic realism. This confirms the findings of Oh et al. [17].

Considering regularity, the design should only be there when you want it to.

While it is not clear whether control influences design directly, it can influence factors like privacy.

The type of synchronicity does not influence design. Both types are found in the final designs.

Device agnosticism

During the project, it was attempted to define device agnostic standardized languages that facilitated exchange of social presence information. However, the space of proposed designs is too diverse to attempt to define a device agnostic standard. For example, the researcher attempted to work out a model for pointer devices which included mice, touchscreens, and hands (Figure 14). This quickly grew in complexity while just including a niche of the design space.

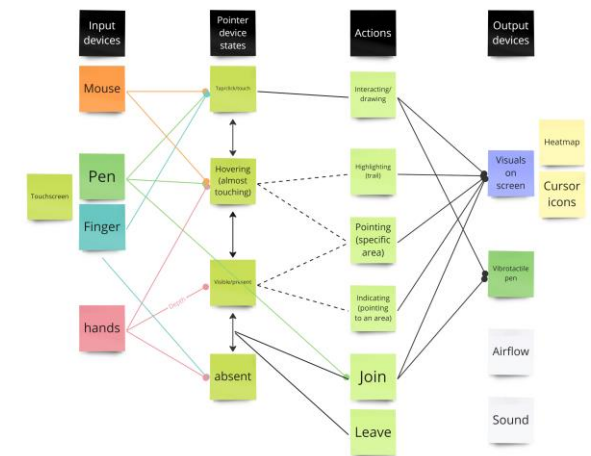


Figure 14: mapping language for pointer devices.

Even these findings allow for speculation about a way all these features be standardized across devices. A lot of social presence features like visualized hands, the heatmap, the vignette caused by picking up the pen and gaze visualization have in common that they are visual in nature. However, little other things about them can be generalized.

Therefore, I propose a ‘canvas’ for whiteboard software that can display any kind of visual (Figure 15). First- and third-party plugins could then draw the visualizations to this canvas. Plugins can detect capabilities of the user’s device (size, performance, modalities etcetera) and tailor their generated visuals with the received data. For example, a new large interactive touchscreen might be able to show 3D hands while an old Chromebook would show hand icons. In practice, this canvas would encompass multiple canvases that can overlay that can both be in front and behind the whiteboard content.

The secondary feature of this canvas should be its capability to talk to connected devices like (depth) cameras, smart pens, lights, motors, and other modalities that are integrated in or connected to the device.

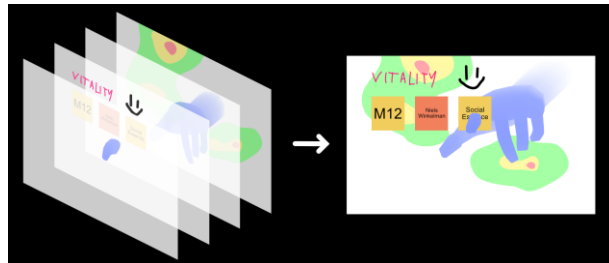


Figure 15: Visualization of canvas concept

CONCLUSION

From the expert contact moments, the demoday and the user study it becomes clear that it is possible to make low-threshold social presence designs that can heighten the social presence experience of users while still being viable for consumer products. A list of key factors has been defined that influence low-threshold social presence

design. Although the list lacks proper validation, it can be used to evaluate, compare, and improve design. The design area of low-threshold social presence remains to be further explored.

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APPENDIX A: USER TEST QUESTIONNAIRE

The questionnaire questions without the likert scale ranking (-2 to 2, Strongly disagree, Disagree, Uncertain, Agree, Strongly agree).

Part 1:

The hands visualizations that you just saw were a type of CMC messages. Please answer the next questions about the CMC messages.

Questions
1. CMC messages are social forms of communication.
2. CMC messages are an informal and casual way to communicate.
3. CMC messages convey feeling and emotion.
4. CMC is private/confidential.
5. CMC messages are impersonal.
6. CMC is a sensitive means of communicating with others.
7. Using CMC is a pleasant way to communicate with others.
8. Users of CMC normally respond to messages immediately.
9. The language people use to express themselves in online communication is stimulating.
10. It is easy to express what I want to communicate through CMC.
11. The language used to express oneself in CMC is meaningful.
12. The language used to express oneself in online communication is easily understood.
13. I am comfortable participating, even I am not familiar with the topics.
14. CMC is technically reliable (e.g., free of system or software errors that might compromise the reliability of your online messages reaching ONLY the target destination).

15. CMC allow relationships to be established based upon sharing and exchanging information.
16. CMC allows me to build more caring social relationship with others.
17. The aggressive over-participation of others in CMC may cause me to participate less in CMC.
18. It is unlikely that someone might obtain personal information about you from the CMC messages.
19. Where I access CMC (home, office, computer labs, public areas, etc.) does not affect my ability/desire to participate.
20. CMC permits the building of trust relationships.
21. The large amounts of CMC messages (numbers of messages and length of messages) do not inhibit my ability to communicate.
22. My computer keyboarding skills allow me to be comfortable while participating in CMC.
23. I am comfortable with the communication styles employed by CMC users.
24. It is unlikely that someone else might redirect your messages.

Social Essence

Part 2 (performer):

The next questions concern the following feature: visualized hands.

Questions
I noticed the feature
I understood the feature
The feature was useful for achieving the given task
The feature made me feel that I was in the room with another participant
The feature helped me convey information to the other participant
The feature on the screen represented well what the other participant was doing.
The feature distracted me
The feature was easy to learn
I felt like I had control over the feature
The feature was only there when I needed it

Eindhoven, Netherlands

Part 2 (receiver):

The next questions concern the following feature: visualized hands.

Questions
I noticed the feature
I understood the feature
The feature was useful for achieving the given task
The feature made me feel that I was in the room with another participant
The feature helped me understand information that the other participant conveyed
The feature on the screen represented well what the other participant was doing.
The feature distracted me
The feature was easy to learn
I felt like I had control over the feature
The feature was only there when I needed it

APPENDIX B: HIGH QUALITY IMAGE OF IDEA SELECTION USING KEY FACTORS

		Input	Output	Realism/abstr action	Realism type	Pairing strength	Relevance	Obstruction/distracti on/impairment	Threshold	Privacy	Control	Who	Synchronicity	Regularity
Gaze visualization		Gaze	On screen	Somewhat abstract	behavioral	Direct	Behavior not always relevant	Might be distracting	Medium threshold	Not inherent No control over activation Can be made private	Little control	Other party users have less control over pointing	Happens in the moment	Happens most of the time Also there when you do not need it Can we fix this? Difficult to control
Vibrotactile pen		Pickup	Haptic	Abstract	behavioral	Somewhat	A little relevant	Little obstruction vibration might impair drawing	low-threshold	Very private	Control	Both users	Happens in the moment	Only when you need it
Hands		Hands	On screen	Minimally abstract	behavioral	Direct	Relevant	Little obstruction, every hands and movements be distracting	Low-threshold	Private	Control	Both users	Happens in the moment	Only when you need it
Depth presentation		Full body	On screen	Realistic	behavioral photographic + anthropomorphic realism	Direct	Relevant	Obstruction	Medium threshold	Not private	A little control	Both users	Happens in the moment	Happens most of the time
3D-board		Full body	On screen	realistic	photographic + anthropomorphic realism	Inherent	Relevant	Obstruction	High-threshold	Not private	Little control	Both users but mostly other party	Happens in the moment	Happens most of the time
dBoard		Full body	On screen	realistic	photorealism	Inherent	Relevant	Distraction	High-threshold	Unprivate	Little control	Both users	Happens in the moment	Happens most of the time
People on screens		Upper body	On extra screen	realistic	photorealism	Inherent	Not relevant to the task	No distraction	High-threshold	Unprivate	Little control	Both users	Happens in the moment	Happens most of the time