ChameleonMask: Embodied Physical and Social Telepresence using human surrogates

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Abstract
Chameleonmask is a telepresence system that shows a remote user's face on the other user's face. While most telepresence systems have been designed to provide a remote user's existence with a teleoperated robot, the system uses a real human as a surrogate for another remote user. To do this, a surrogate user wears a mask-shaped display that shows a remote user's live face, and a voice channel transmits a remote user's voice. A surrogate user mimics a remote user by following the remote user's directions. This design is based on our hypothesis assuming physical and social telepresence can be embodied by such a surrogate human who imitates the remote user. It also eliminates many difficulties of teleoperated robots wandering in the environment. Our pilot study confirmed that people could regard the masked person as a right person.

Author Keywords
Telepresence, Embodiment, Presence, Augmented Human

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous. for help using the ACM Classification system.

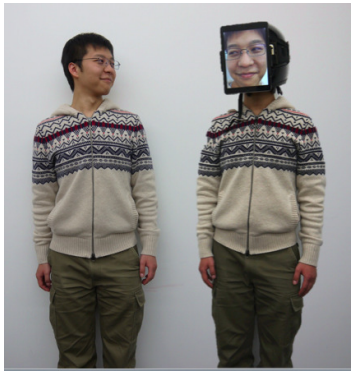


Figure 1: The remote user can get his surrogate wearing ChameleonMask.

Figure 2: This is a prototype system of ChameleonMask. iPad air is held on full face helmet. Hacosco put in iPhone6 is set on eye part.

Introduction

Since Marvin Minsky predicted telepresence[9], a significant amount of research and resulting systems have been produced. To accomplish a sense of "being there", a remote user and a removed environment are both connected to an objective place in order to communicate with local members.

Autonomous robots[8] are telepresence systems that allow remote users to freely travel around an objective place by teleoperating the system. These systems display a human face on their screens and replace wheels with legs, which replicates the remote user's presence and mobility in a distant location. Autonomous robots have been introduced in many situations. For example, some companies have introduced these systems to their offices[1], and more researchers are using these systems at academic conferences[2].

Igarashi, who uses an autonomous robot at the first time stated, *"I had participated conferences using "Ustream" streaming before. However, there was a 'physical existence' with autonomous robots. I felt like actually being in the same space with the local participants. This experience was very surprising and exciting."* [3] As can be seen, these systems produce satisfaction and a feeling of physical presence. In addition, local users also have a more realistic sensation of the remote user's presence when an autonomous robot is used [12].

[1]Double, http://www.doublerobotics.com/business/

[2]Should I Attend a Conference Via a Telepresence Robot?, http://spectrum.ieee.org/automaton/robotics/industrial-robots/attending-conference-via-telepresence-robot

[3]The reason why I could attend in conference from 200km far way with a child first 2weeks after delivery.(in Japanese), http://by-lines.news.yahoo.co.jp/yukiigarashi/20141211-00041418/

However, these systems are still imperfect. Substituting physical human existence in the real world is difficult, and many issues that address this limitation have already been revealed.

- A difference in appearance influences human communication [13], however the system's and remote user's physical appearances don't correspond. For example, although the system's height may be adjustable, in order to maintain its stability, the machine is often smaller than the user.
- A mobile telepresence robot's volume control system must adjust to the environment [4]. For example, when a remote user asked a presenter a question, the robot's voice was too quiet, requiring staff to repeat the remote user's question instead. Another user reported a volume level that was too loud due to a lack of available volume adjustment.
- Even though a system is "autonomous", it still needs human help every time a problem occurs. Irene et al. [12] mentioned that tasks with high mobility requirements decreased the system's performance. In this case, special support is necessary in order to increase task performance. Furthermore, controlling these robots in a remote place is difficult. Autonomous robots frequently leave obstacles on the floor or stairs. As a result, the system does not blend well into local atmospheres. If multiple people simultaneously used autonomous robots, even large spaces would be occupied.

In order to address these problems, we propose a surrogate human, which embodies the remote user's physical and social telepresence. Many telepresence studies have used autonomous robots, or robots that behave like humans. However, we propose the use of an

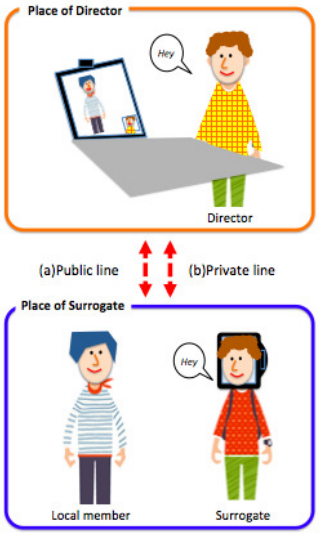


Figure 3: Director sees the place of surrogate and communicate with a local member through his surrogate. There are two communication lines, (a)public line and (b)private line.

actual human. Humans inherently have crisis-control capacities and five highly developed senses. If the remote user can find a surrogate who looks like him or her, the impression of his or her appearance can be maintained. The surrogate can naturally adjust volume using his or her ears in order to adapt to varying circumstances and does not become a nuisance to local members.

In order to confirm this hypothesis, we developed a prototype system called ChameleonMask (Figure 1,Figure 2). ChameleonMask has two communication functions. The first function is a public communication line between the remote user and the local audience. The second function establishes a private communication line between the remote user and the surrogate. The remote user provides directions that the surrogate enacts with his or her body. Furthermore, we conducted two pilot field tests in order to determine people's response to this system. Finally, we discussed the surrogate's motivation for helping the remote user.

ChameleonMask

ChameleonMask is a human-human communication mask system in which a remote user possesses a surrogate. Because of the surrogate's physical reality, the remote user can demonstrate a physical and social presence in a local place.

Stakeholders:

Three primary *stakeholders* exist in our concept: a remote user, a local user (the surrogate), and local party members (Figure 3).

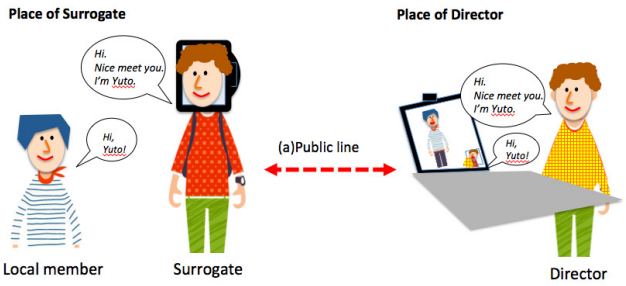
Remote user as director: We call the remote user the "director." This is the person who wishes to participate in a remote place and gives his or her surrogate direction concerning where to go and how to act. The director acts as though present in a local place, but the surrogate operates within the location.

Local user as surrogate: We call the local user the *"surrogate"*. The surrogate is the user who receives direction from the director and acts on behalf of the director. The surrogate works for the director as the director's remote body and shares the local environment and situation through video and voice. The surrogate does not talk with local party members but lends his or her body to the director. Therefore, the surrogate must abate his or her character and presence in every way except bodily.

Local party members: These are the users who see the surrogate. For example, these could include the director's colleagues or other participants in a conference.

Physical Presence

Telecommunication must embody the remote user's existence. In our system, the remote director's presence is produced using the surrogate's physical body. Therefore, the surrogate should resemble the director as much as possible. For example, the surrogate should dress in a manner similar to that of the director. Equivalent height, body type, and gender are appropriate attributes for the director's surrogate.



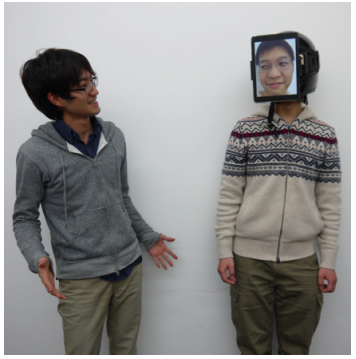


Figure 5: The remote user is talking to the local user through the surrogate.

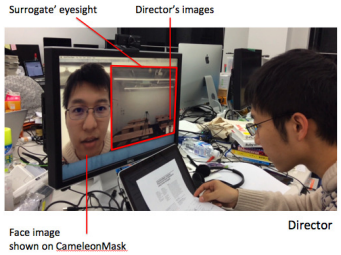


Figure 6: This image shows the director uses the system.

Figure 4: (a)Public line is a channel between a director and local party members. Face Images and Voice are sent to public.

Social Presence
Facial recognition is the primary method humans use to visually distinguish one another. Therefore, the mask-shaped display must exhibit the director's live face, and a voice channel transmits the director's voice. Some methods for meeting these system requirements include the following. The first method incorporates face-mask projection. LiveMask is a rear-projection system that projects an image onto a face-shaped screen [10]. Projecting enables a high level of expression, such as facial details and motion [1]. However, these techniques do not suitably apply to wearable systems due to their lack of projector placement. Willis et al. [16] introduced a three-dimensional (3D) printing custom optical element technique. Here, a curved 3D optical display can be projected onto an arbitrary place without interfering with the surrogate's face. However, a flexible display that can shape to the face, which is a topic for future research, would improve this method.

Before developing the mask, we constructed a prototype system in order to experiment and ascertain people's feelings regarding these kinds of systems.

Two Communication Lines:
ChameleonMask has two communication lines. One is a public line and the other is a private line. The director switches between the public and private channels when responding to conversation.
Public line: The remote director uses the public communication line in order to communicate with local party members using a live face image and voice communication (Figure 4,Figure 5,Figure 6). In our prototype system, we used an iPad air to implement these functions. The face size is aligned with that of the iPad air, which is 9.7 in tall. If the voice's volume is too low, the surrogate adjusts the volume on the iPad or uses the private line to tell the director to raise his or her voice.

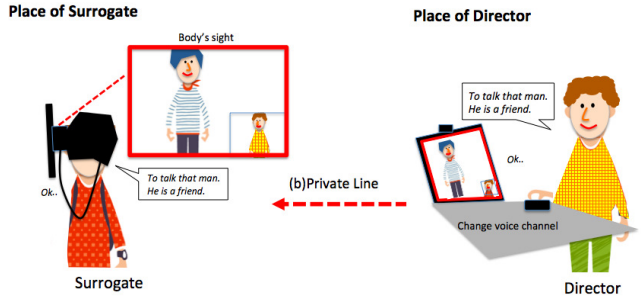


Figure 7: (b)Private line is a channel between a surrogate and a director. Giving instruction from the director to the surrogate directly. Sharing surround environment from the surrogate to the director with eye sights and voices. Voice communication connected only between two.

Private line: The private line relays communication between the surrogate and director (Figure 7). Video images and a voice channel are sent from the surrogate. The director must mute the public audio line before using the private line. This channel is supported on Google Hangouts[4]. The surrogate wears an earphone with a microphone in order to talk with the director. The surrogate does not talk when the director is speaking with a local member. When the surrogate uses the private line, he or she should speak at a lower volume. If the surrogate quietly speaks under the mask, then local members are less likely to notice. In addition, when the surrogate wears the mask, his or her vision is blocked. We used a Hacosco

[4]Hangout, http://www.google.com/+/learnmore/hangouts/?hl=en.

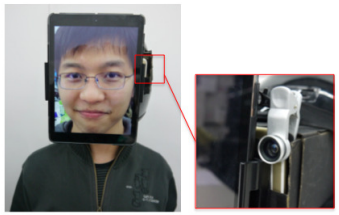


Figure 8: Surrogate sees the landscape in part of red square. Wide lens is attached on outside camera.

one-eyed model[5] in order to acquire the surrogate's vision so that he or she can face a speech partner and safely walk around.

The Hacosco model is a cardboard virtual reality (VR) helmet-mounted display (HMD). Placing a smartphone in the Hacosco helmet allows the surrogate to see and immerse easily. We chose the iPhone6 for this system considering its wide-screen capacity, weight, and built-in camera (Figure 8). Our prototype system uses a full-face helmet, which ensures unobstructed breathing. In order to render the mask comfortable, it was made to be adjustable to the surrogate's head, and nose space was created directly in the Hacosco. Additionally, in order to produce a wider view, we attached a wide lens to the camera. Consequently, the range of vision expanded twofold, and the surrogate was able to walk straight using the sight provided by the Hacosco. These images are shared with the director in real-time, and the surrogate can see the director's gestures in the lower right corner of the screen.

Pilot Field Test

In order to determine our system's distinctive features, we conducted two field tests. Scenario 1 included a surrogate that traveled to the city government and received a public document in place of the director. Scenario 2 involved a surrogate communicating with an old person in place of her grandchild. Our goal was to assess people's reactions to and feelings about our prototype system.

Scenario1

A 28-year-old woman (director) needs a certificate of residence. She must visit the city center in order to receive it, but she is unable to travel there for some reason. Therefore, someone else must visit the office in her stead.

[5]Hacosco, http://hacosco.com/en/.

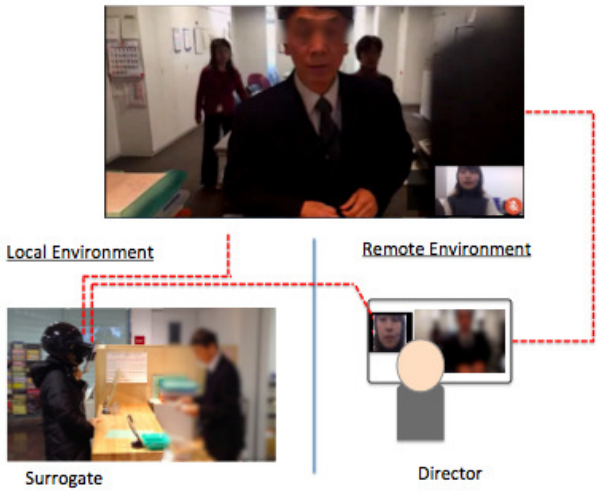


Figure 9: Experiment1.

In this scenario, the surrogate wears ChameleonMask and asks a city officer to issue the certificate. Officially, citizens can only acquire a certificate of residence with their own identification (ID) at the city office. When a citizen appoints an agent, the agent must have an authorization letter from the citizen. The purpose of this test is to determine whether a city officer will publish the certificate of residence for a masked surrogate and to ascertain the reason he or she would or would not. Therefore, the surrogate travels to the city office with the director's ID card and request for a certificate of residence.

How the field tests was conducted

In order to conduct our test, our operator asked the director to find a same-gender surrogate. The director found a foreign 23-year-old female student, who was introduced by a mutual friend. The director and surrogate met for the first time during our test. The operator then

asked the director to visit the city center in order to familiarize herself with the location and acquire a request form for the certificate of residence. When the director took this request form, the city officer talked with the director, providing help. After this, the director told her to return after filling out the request form. The operator instructed both the director and surrogate to use our system. Before initiating the field test, the surrogate wore ChameleonMask in order to acclimate herself to the system's structure. After some trials, the surrogate and an attendant, who aided during the acclimation process, left the experimentation room. The surrogate had not visited the city office before, so the director guided the surrogate using the private communication line.

In the following transcript, ( ) denotes communication limited to that between the director and surrogate. Here, D represents the director, P the surrogate, and O the officer.

D: (The office counter is at the end of the hall. Go straight forward and look right.)
P: (Okay. I walked into the building...and arrived at the counter.)
When our masked woman visited the city office's counter, all officers rose to their feet. The supervising officer walked to the counter.
D : Excuse me, I need my certificate of residence. This is my ID card and a request form.
The surrogate handed over the ID card and request form.
O : Ah...
The officer examined the face on the ID and that on the mask.
D : It's me.
O : Yes, we checked, and you are the right person. But would you take off your mask, please?
D : Sorry, I can't. This body isn't mine. I can't go there, so I let my agent visit the city office.
O : Pardon? You are not the person on this ID?
The officer clearly assumed that the surrogate under the mask was the director.
O : Okay. If you are her agent, you need an authorization letter because...
After realizing the body belonged to an agent, the officer politely explained the rules.
D : (Okay, we'll stop requesting the document.)
D : Thank you very much for your kind explanation, officer.

Observation and Findings
The city officer identified the ID card and the director's face, which was displayed on the iPad. However, he asked the surrogate to remove the mask. When the director explained that the body was not hers, the officer recognized that the masked person was an "agent." After the field test, the director visited the city office and explained the field test. The officer said, "I knew *you* came here," and talked with her while taking the request form. The officer explained the reason they could not publish the paper without an authorization letter. According to her, they must treat personal information with care, so if a person is not the "right one," they do not hand over certificates. However, before saying *"the body is an agent"*, the officers seemed to recognize that the masked person was the right person. She said *"By law, we can't give you the certificate right now, but we don't know if the rules will change in the future."*

Surrogate's comment:
It was a very interesting experience to became another person. I could see the city officer's troubled face without revealing my own face. The task in becoming the

director's surrogate was not difficult. I just walked and stood as instructed. I may consider becoming someone's surrogate as a part-time job. I felt that my work helped someone else.

Scenario2
A 28-year-old granddaughter (director) returns to her hometown in order to attend a New Year's party with her family. She has not seen her 87-year-old grandmother for some time. The grandmother is not technologically minded and suffers from mild senility. She loves her granddaughter very much. The granddaughter arrives; however, her identity masks that of her mother (surrogate), who wears the ChameleonMask. The purpose of this test is to determine the reaction of an elderly person to her masked granddaughter. In particular, we wish to observe whether the grandmother believes her granddaughter is present and whether or not she responds with anger?

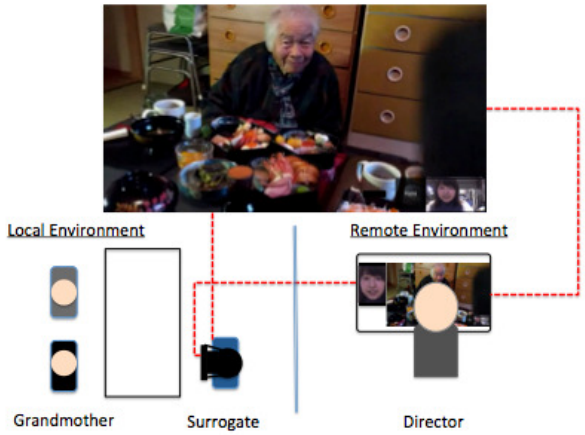


Figure 10: Experiment2.

How the field tests was conducted
We recruited a family, which was comprised of a grandmother, father, and mother, who all live in the country, and their daughter, who resides in the capital city. The granddaughter rarely returned home, and her grandmother was eager to see her. In this test, the granddaughter was the director and her mother was the surrogate. They look alike and have similar body types. Because the mother regularly saw the grandmother, she donned her daughter's clothes. The test was conducted at the grandmother's home. The participating family members, excluding the grandmother, first familiarized themselves with the system. Afterward, the daughter practiced giving directions from the living room, and the surrogate mother imitated her daughter. The father conversed with the grandmother until the surrogate entered the room. After some practice, the mother (surrogate) approached the grandmother.

In the following transcript, ( ) indicates communication between the director and surrogate, D represents the director, P denotes the surrogate, and G symbolizes the grandmother. Also, XX signifies the daughter's name. This was recorded after the surrogate opened the door.

D: Hi,Grandma! Long time no see! How have you been?
G: Oh, XX! ...Are you XX? A little strange...I'm too old to stay healthy.
When the grandmother first saw the surrogate, she was surprised. However, the conversation between the director and grandmother continued.
D : I came back from Tokyo today. It's colder here.
G: Yes, it's cold here. By the way, do you know the old woman living next door passed away...
Everyone listened to the grandmother talk for a while. However, the director scratched her chin, and her fingers

appeared on the iPad screen.
G: You have two hands here. Why do I see the other hand (on the iPad)?
The grandmother was confused. Then she began commenting on her granddaughter's appearance.
G : XX, you became pretty. Your skin is very beautiful, and your teeth are also nice.
D : They are? Thank you.
G : Hey XX, why do you wear this mask? Please let me see your face, I want to see you directly.
D : (Can you hear me, Mom? Let's take off the mask now.)
The surrogate removed her mask.
P : Sorry, Grandma. I am not XX. It' me.
G : What?? Why are you XX's mother?
The grandmother was very surprised.
D : Sorry, Grandma. I didn't come back home.
The director lied to the grandmother, and the grandmother was very disappointed.
G : I see... XX isn't here.
Shortly thereafter, the director entered the grandmother's room.
D : Hey, Grandma. I'm sorry for telling a lie. I' m back.
The grandmother's surprise heightened in this moment.

Observation and Findings
The grandmother exhibited fear in response to the unfamiliar visual display at first, but she believed her granddaughter had returned home. The grandmother had the opportunity to realize that her granddaughter was not the masked person when the granddaughter scratched her chin. However, the grandmother did not understand what she was seeing on the iPad's screen. When the grandmother understood that the surrogate was the mother, she was discouraged and looked down at the table. She thought her grandchild had not returned. We asked her how she felt about this system after the test. She said, *"It's too difficult for me to understand."* She repeated this sentence many times. The grandmother was unable to comprehend the framework, but she had trusted that her granddaughter "was there."

Surrogate's comment:
Grandmother really believed her granddaughter came back home. I felt that she talked to me as if I was her granddaughter. I'm glad to see her smile. I think this system could be used in nursing homes. There are many elderly people who want to talk with their family. When the family can't visit, this system could connect the family with their elderly relation.

Discussion

Physical and Social Telepresence
In this paper, we conducted two pilot field tests. We hypothesized that people would be skeptical of the mask, look at it in disbelief, and immediately request the surrogate to remove it. However, we did not observe this reaction by either the city officer or the grandmother. They were both polite and kind. We suggest that this is due to the facial images displayed on the top of the surrogate's body. Local participants acknowledged the surrogate's humanity and thought they confirmed her identity. Therefore, they did not ignore the surrogate but treated her like a human being. One of the surrogates also said that she felt participants turned and talked to her as if she were the director. They seemed to believe that the remote user was in front of them. Thus, the surrogate was not only physically present but also created a sense that the director "was there."

Methods for directing a surrogate
In this prototype system, the director and surrogate communicated audibly. However, alternative methods of providing direction exist. Also, deciding which information needs to be conveyed is significant for both members. For example, when the director uses the private line, his or her lips move. The voice is muted for local members, but the lips could still be read.

Reliability
Questions arise concerning the reliability of the proposed system. For example, will local members trust the surrogate as they would the director? Can directors have confidential conversations with local members when using a surrogate? Must the surrogate trust or comply with the director when in trouble?

Related Work

Many research projects concern telepresence, especially as it relates to the study of autonomous robots because mobility enhances a remote user's presence [12]. These systems are composed of a tablet, speaker, and microphone. Geminoid[14] is an android system that has a human-like avatar. Its appearance is substantially real, but its mechanical structure is complex. This system's motion is limited by the remote user's movement. Although there are telepresence systems that convey the haptic senses, in addition to vision and audio [15], and enable a full existence experience, they require an inordinate amount of resources. Our approach uses innate human abilities in order to achieve telepresence. Haptic Turk is another approach that allows the motion experience by leveraging humans [2]. Furthermore, whereas Amazon Mechanical Turk[6] is a brain marketplace, ChameleonMask can be a physical one.

Some studies have also investigated remote user controls in order to share experiences with local users. For example, Tele-Actor [3] is a system that is worn in order to communicate a remote environment. ChameleonMask conveys not only the remote environment but also the remote user's presence on mask. Omnipresenz[7] offers the social service concept of visual sharing. Additionally, Teroos is a wearable system, placed on the shoulders, in which a remote user communicates with a local user through a small robot [7]. Because face-shaped screens aid in effective communication using eye contact [11], some researchers have focused on visual sharing. Kori et al. [5] proposed the video communication system design for sharing experiences, and Jackin [6] is a system in which the local user transmits 360-degree vision with the remote user using a headset equipped with cameras. In this system, the remote user's presence relies on the local user. The ChameleonMask system also relies on the surrogate to relay the remote user's presence. However, in this system, the local user is a surrogate for the remote user and acts in response to the director's requests.

Conclusion and Future Plans

We proposed a telepresence system called ChameleonMask in which human-human communication includes a remote user (director) and a local user (surrogate). We hypothesized that physical and social telepresence can be embodied by the surrogate, who imitates the remote user. We developed a prototype system in order to investigate this concept and conducted two field tests. Our results suggest that local listeners tend to believe that the masked surrogate is the director, which induces a "being there" experience. We also discussed multiple potential applications for this system.

[6] Amazon Mechanical Turk, https://www.mturk.com/

[7] Omnipresenz, http://www.omnipresenz.com/

A potential limitation of the proposed system is its requirement of a surrogate's cooperation. Therefore, the design must include a means of motivating potential participants, ensuring they would like to be surrogates. In our field tests, the surrogates indicated that they experienced a sense of satisfaction, which resulted from helping others. Our future plans involve conducting further field tests in order to acquire more knowledge and a deeper understanding of our system's attributes because we believe that appropriate telepresence systems should reflect both human relationships and diverse situations.

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Commentary

For alt.chi paper
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At an event called Stupid Hackathon, held in New York in early 2015, one creation was called *iPad on a Face*. It was "*a telepresence robot, except on a human*" (www.stupidhackathon.com).

Enabling a remote person to use a human surrogate in a mobile telepresence system is an idea I find troubling. What would it be like to interact with someone via a human surrogate? What would it be like to be that surrogate? These questions are provoked by systems such as *ipad on a face*, but to answer them requires real world user trials.

A decade ago Sheridan et al. (Understanding Interaction in Ubiquitous Guerrilla Performances in Playful Arenas, Proc. British HCI, 2004) went some way towards answering such questions. The *Schizophrenic Cyborg* was a wearable system that enabled someone to interact with a remote person via a display attached to a third person's chest. The system was trialled in nightclubs. Sheridan found that the remote person would engage in playfully awkward interactions, such as asking people to give the wearer a hug. The experience for the wearer was, understandably, disconcerting.

More recently, Reeves et al. (I'd Hide You, Performing Live Broadcasting in Public, Proc. CHI 2015) have explored a mixed reality game *I'd Hide You* in which runners broadcast video, enabling remote players to direct them around a city in an attempt to capture other runners. The runner is not a surrogate in quite the same way as the other systems, but a similar dynamic occurs with the runner working with and for co-present and remote others.

Misawa and Rekimoto's ChameleonMask has similarities with these other systems. However, ChameleonMask has not been trialled in the playful context of a game or nightclub, but in ordinary situations. Moreover, the situations in the trial are ones in which identify and presence are topical and practical matters for those present. Firstly, a government official, when presented with an identify document by someone wearing the ChameleonMask, is put in a situation where he must decide whether it is the surrogate or the remote user who is is actually presenting the document. Secondly an elderly woman, when visited by a family member via a surrogate wearing the ChameleonMask, has to decide whether to orient to this visit as one by a family member or by a stranger. As such the two studies are akin to the breaching experiments discussed by Crabtree (Design in the Absence of Practice: Breaching Experiments, DIS 2004). The trials address the interactional troubles provoked by the system by its breaching of the norms of identify and presence.

Conducting studies such as these, particularly when outside of the context of games and playful arenas, does pose ethnical challenges. How far can or should we go when breaching social norms? The visit to an elderly woman is a challenging example. Clearly connecting grandmothers and granddaughters is an important area of research for HCI, but we do need to be careful and respectful when creating uncomfortable and disconcerting experiences. As this study affirms, it is not just the surrogate that has a potentially uncomfortable experience, but also those they interact with.