Body as Display: Augmenting the Face through Transillumination

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ABSTRACT

In this paper we describe our explorations of the design space offered by augmenting parts of the human face, in this case, the ears. Using light-emitting add-ons behind the ears we aim to enhance social interactions. Scenarios range from indirect notifications of events, messaging directed to the wearer but communicated via a person face to face, or adding information regarding the internal state of the wearer, like loudness discomfort levels, concentration fatigue, or emotional strain levels.

Author Keywords

Transillumination; indirect notification; face augmentation;

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

In social interactions, we receive many subtle cues about the person from their facial expressions, mimicking cues, and micro-movements. There is even a plethora of digital cues such as notifications that could tell us that our interlocutor is running late for a meeting. However, trends like "calm technology" aim to reduce both invasiveness and disruptiveness of technology to even ultimately conceal their physical presence. In this paper, we argue that creating awareness for such additional information can be helpful in certain situations. We specifically aim to map internal states of a user to indirect notifications. These states can e.g. be gathered through biosensing, or external events such as reminders through transillumination of parts of the face (cf. Figure 1).

Transillumination (shining visible light through the body) has a long history in medicine. Transillumination can e.g. be used to visually detect dental traumas and caries or excess of cerebrospinal fluid (CSF) in the skull of infants. An example in popular culture is Spielberg's *E.T. the Extra-Terrestrial*, here E.T.'s finger tip glows sporadically, and in a dramatic turn of events, his heart begins to glow.

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In the following, we introduce related work, exemplify a first wearable prototype dubbed GlowEar that uses transillumination of the ear and, finally, sketch and discuss potential user scenarios.

RELATED WORK

More recently there have been attempts in product design to augment the expressiveness of the face and the body: by adding brain-wave induced cat ears and as a wiggling tail (Shippo/Tailly [5]). These gadgets are intended as a social-interaction and conversation-starter utility. In contrast to adding artificial body parts, our orthosis approach is meant to remain invisible unless it is emitting light.

In fundamental research there has been progress on the technical development of subdermal Light Emitting Diode (LED) meshes [1]. In the design of future scenarios there have been concepts and sketches of using such subdermal LEDs as tattoos. Our attempts, on the contrary, are meant to be easily removed, more like jewellery than like permanent body modifications. Katia Vega's *beauty tech* research [6] and Mitani et al.'s *Tearsense* [4] get as close as possible to body by working with active make-up. Parts of the face have also been explored as interactive surfaces. Probably closest to our agenda, Lissermann et al. [3] explored using the ear as an input device.

With respect to indirect notification, we want to mention Wang's *Asimov's First Law scales* [7], where one of the scale

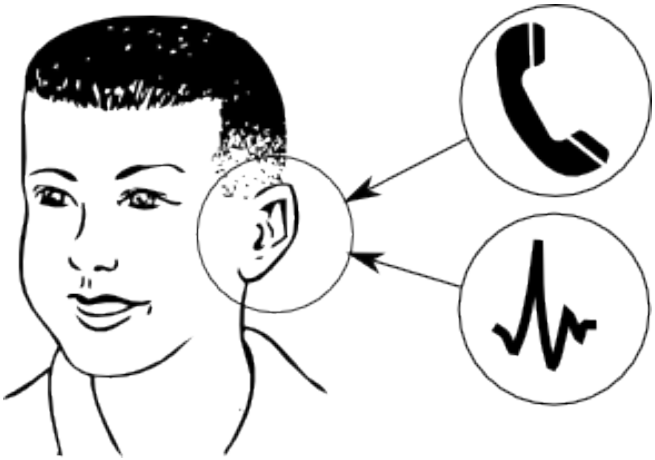

Figure 1. General transillumination concept: here, the ear can be used as a visual indicator for incoming calls and/or to visualize the internal state of the wearer (heartbeat/loudness discomfort/fatigue).

designs call for a second person to read out the measured weight with either a white lie or expressing the true weight, depending on the expected emotional impact.

GLOWEAR: CONCEPT AND SCENARIOS

Inspired by the work of Manabe & Ishibashi [2], we began our inquiry by taping a white LED behind each ear and implementing a tilt sensing sensor (mercury switch)/ micro controller setup. We used the analogy of light as fluid. When holding the head straight, the ears are glowing equally. Upon tilting the head to the right, the light intensity of the right ear increases, whereas it decreases in the other ear. This was originally intended for a performance art context. While this is a stunning and entertaining effect, it also triggered thinking around other possible scenarios.

In the following, we describe our *GlowEar* (see Fig. 1) approach for indicating internal processes, those normally not visible to an external viewer. This is followed by the scenario of indirect notification where in social situations, notifications are being displayed without the direct addressee noticing. This is mainly a conceptual approach directed at empowering the conversational partner.

Physical Well-Being

In the context of well-being there is information that is not easily deductible in a social interaction. A common indication individuals do not want to be disturbed is to wear headphones in a shared working space. People also have different levels of comfort when it comes to loudness. By combining *GlowEar* with a microphone (as loudness sensor) it is easily possible to map the amplitude of the sounds reaching the ear to light intensity changes behind the ear. Our approach calls for pre-adjusted thresholds of loudness discomfort levels (LDL) by the user. If LDL is reached, the ears start glowing brightly and only slowly *recover* (light intensity decrease) if the loudness remains below the threshold. The ability to individually adjust LDL indicates awareness that different comfort levels exist in general, and to lower voice when necessary. This concept can be extended through bio-sensing to situations where the other person's concentration levels go down, specifically in instructional situations, or by measuring heart rate or blood pressure to indicate agitation.

Indirect Notification

This approach stands in contrast to the common model where the user of a device gets notified of an event, like an incoming call, directly, via auditive, visual, or haptic feedback. Because receiving a call during a conversation can be perceived as highly impolite, our attempt aims instead for notifying the conversation partner. Through this shift, it is the conversational partner who notices the glowing ears, and in return, can inform the person to whom the notification was originally directed. In this way, it is possible to externalize social awareness, a feature that technical notification usually lack. Additionally the conversation partner receives the information first and is empowered to act upon it in any desired way. This could mean simply ignoring the visual cues in order not to interrupt the conversation, to wait for the right moment for interruption, or simply responding with a smile or laugh at the funny visual impressions.

We speculate that it is exactly the situation of having a choice and ability to act upon it freely, which changes the situation from annoying interruption to one of choice for making an *empowered* decision.

DISCUSSION

While simply shining light through the body certainly results in a warm reddish glow, creating iconographic temporal animation patterns enhances the expressive potential. This becomes necessary as soon as one aims for different messages to be communicated through *GlowEar*.

Transillumination works best in dark or at least dimmer lighting settings. If the LEDs are set too bright, the indirect notification will become direct, as one feels the warmth of the LEDs. Nevertheless we are positive, that transillumination of body parts, and specifically the connected concept of indirect notification, can aid in redirecting the competence of social awareness to humans.

We primarily focused on the augmentation of ears. There are further body parts, like mouth and nose, that are suitable for transillumination. The teeth can be another target of discreet transillumination for transforming the body into a display. This, however requires showing the teeth, e.g. smiling.

CONCLUSION

In this paper, we proposed the augmentation of the ears through transillumination, exemplarily implemented in a prototype dubbed *GlowEar*. We presented scenarios for (i) the visualization of internal states of the wearer and (ii) an indirect notification approach for event notifications in an conversational setting on the other. We hereby hope to enrich ongoing discussions in the Augmented Human community.

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