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Cobb, Robert Dominic; Gross, Tom

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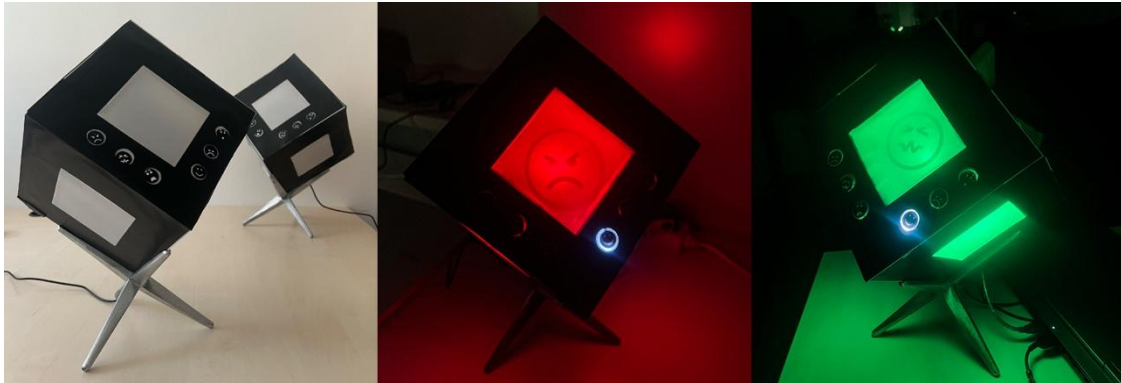


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# Emoji Lantern: An Ambient Interface for Communicating Emotions

Robert Dominic Cobb , Tom Gross  · Human-Computer Interaction Group, University of Bamberg , Germany · [hci@uni-bamberg.de](mailto:hci@uni-bamberg.de)



**Figure 1.** Emoji Lantern, a bidirectional Ambient Interface for communicating emotions through colours and emojis.

**Abstract.** Many users desire a positive emotional connection when using computer-mediated communication. Emojis are commonly used to express emotions and thus constitute a form of emotional communication. However, traditional systems, such as social media and screen-based devices, are associated with negative experiences for some users. To address these needs, we created Emoji Lantern, a bidirectional Ambient Interface that communicates the emotions of persons in close relationships. Emoji Lantern allows users to share long-lasting emotion cues. It displays an emoji using a shadow projector as well as coloured ambient light. We designed Emoji Lantern as an always-on background medium. It is intended to make users feel emotionally connected, i.e., to facilitate Connectedness.

**Keywords.** human-centred computing, human-computer interaction, interactive systems, connectedness, ambient displays, emojis, prototype

## 1 Introduction

Humans have a fundamental need for connection (Kerr & Kurtz 2024; Murray & Pascuzzi 2023). Many in long-distance relationships may rely on computer-mediated communication (CMC) to fulfil this need. However, the use of traditional systems, such as social media, has been associated with lower well-being and feelings of loneliness (Bonsaksen *et al.* 2022; Clark *et al.* 2017). These associations are linked to “behaviours that do not help to meet users’ needs for acceptance and belonging” (Clark *et al.* 2017, p. 35). Negative experiences lead many users to seek to reduce their use of screen-based devices (Zhang *et al.* 2022). On the other

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hand, when the user’s connection is increased, associations are typically positive, such as increased well-being (Clark *et al.* 2017).

The sense of being in touch with one another is known as Connectedness, which “can be strong and the experience highly appealing” (Ijsselsteijn *et al.* 2003, p. 928). It can be experienced in intimate relationships, but also in other close relationships (e.g., between family members or friends) (Murray & Pascuzzi 2023). Connectedness may also help persons experiencing loneliness. “[L]oneliness at a problematic level is a common experience worldwide” (Surkalim *et al.* 2022, p. 7).

Ambient Interfaces are particularly suitable for facilitating long-lasting interactions, such as Connectedness (Omran & Gross 2016). “They present digital information through subtle changes in the user’s physical environment such as variations of light, sounds, or movements” (Gross 2003, p. 68). They act as background media, intended to complement rather than interrupt the user’s foreground task (Gross 2003; Gross 2008; Wisneski *et al.* 1998). Ambient Interfaces facilitate Connectedness through “implicit, personal, and expressive communication, as opposed to the explicit, goal-oriented, and informative communication characterising most CSCW systems” (Strong & Gaver 1996, p. 29).

Emotions play a central role in creating feelings of Connectedness between geographically separated persons (cf. (Ijsselsteijn *et al.* 2003; Strong & Gaver 1996)). They are often expressed nonverbally, such as through facial expression (Buck 1988). In CMC, emojis serve as a substitution for nonverbal communication (Krekhov *et al.* 2022). “The most important function of face emojis remains the visualization of emotions based on the underlying facial expressions.” (Krekhov *et al.* 2022, p. 2). In addition to emojis, colours can also be associated with certain emotions (cf. (Jonauskaite & Mohr 2025)).

Based on these insights, we present Emoji Lantern, a bidirectional Ambient Interface which helps users remain emotionally connected while apart, thus creating a sense of Connectedness (cf. (Ijsselsteijn *et al.* 2003)). It allows users to communicate their emotions through long-lasting emotion cues, i.e., an emoji paired with coloured ambient light. For example, positive emotion cues, such happiness, may make users feel in touch, and negative emotion cues, such as anger, fear, or sadness, may encourage users to reach out to one another.

## 2 Related Work

Some Ambient Interfaces inspired our work (Bloemraad *et al.* 2020; Kim *et al.* 2022; Liu *et al.* 2021; Raudanjoki *et al.* 2020). There are several examples of Ambient Interfaces which incorporate light. For instance, Lumino, “an interactive lamp that enables users to record their daily emotions with colored light” (Kim *et al.* 2022, p. 1716). Lumino is not intended to facilitate Connectedness but serves as personal mood diary.

Another example is ShadowSparrow, an Ambient Interfaces as a desk lamp “that carries information through functional lights and shadows” (Raudanjoki *et al.* 2020, p. 351). ShadowSparrow projects shadows onto the user’s desk. The primary purpose of ShadowSparrow is to be informative to the user and to deliver notifications rather than to facilitate Connectedness.

The last example is an awareness tool designed by Bloemraad *et al.* (2020). This Ambient Interface is intended to “raise awareness among players” (Bloemraad *et al.* 2020, p. 189) during long gaming sessions. “The device can be placed freely on a desk and uses lights to gently remind players to take a break from time to time” (Bloemraad *et al.* 2020, p. 191). This system does not facilitate Connectedness but presents information to the user through colour-coded light.

Emojis have been explored in Ambient Interfaces as well, albeit less frequently than light and colours. One such system is LUNOST, which provides “a new form of remote intergenerational social interactions through sharing emojis and sending voice messages.” (Liu *et al.* 2021, p. 129). LUNOST connects college students and their parents. The authors “envisioned LUNOST as an ambient device for social interactions” (Liu *et al.* 2021, p. 131). However, Ambient Interfaces typically take advantage of the physical environment (Gross 2003; Wisneski *et al.* 1998). In contrast, the interaction with LUNOST is more explicit, and users require focal attention. It presents information using an OLED screen and is held in the users’ hands (Liu *et al.* 2021).

To the best of our knowledge there are no Ambient Interfaces, which attempt to facilitate Connectedness through colours and emojis, while making “use of the entire physical environment as an interface to digital information” (Wisneski *et al.* 1998, p. 2).

### 3 Design

We designed and implemented Emoji Lantern, a pair of Ambient Interfaces that communicate the emotions of geographically separated persons in close relationships. We first created 3D models of what we envisioned Emoji Lantern to look like (cf. Figure 2). Blender 4.2.3 LTS was used for 3D modelling, and the emojis were designed in Adobe Illustrator 2025. After the ideation phase, we created detailed 3D models of the internals.

The system is bidirectional and works stand-alone—that is, the users do not need to interact with a computer. Emoji Lantern allows users to send emotion cues by simply pressing buttons on the device as well as receiving emotion cues in real time. It provides senders with visual feedback. A shadow projector displays the selected emoji on the recipient’s side. These emotion cues consist of emoji-colour pairs representing specific emotions.





Because emotions vary in their duration (cf. (Verduyn 2021)) Emoji Lantern is not intended to communicate the emotion the user is necessarily experiencing at a moment, but rather the emotion they choose to share with the other user. Emoji



Lantern was intentionally designed as a background medium that slowly presents information (cf. (Gross 2003)). When a user sends an emotion cue, it persists until the user decides to change it.



**Figure 2.** 3D rendering of a model showing how we envisioned Emoji Lantern during the design process and the shadow projector of our final prototype.

We designed unambiguous emojis, specifically intended to represent certain emotions (cf. Table 1). The emotions are the six basic emotions (anger, disgust, fear, happiness, sadness, and surprise), which are clearly captured by the facial expression as well as easily recognisable across cultures (Ekman 1971; Ekman 1978; Ekman 1992; Ekman *et al.* 1971). We decided against adding a neutral face emoji because it can be perceived as negative rather than convey the intended neutral meaning (cf. (Krekhov *et al.* 2022; Scheffler & Nenchev 2024a; Scheffler & Nenchev 2024b)).

Emotion (Ekman 1971; Ekman 1978; Ekman 1992; Ekman <i>et al.</i> 1971)	Facial expression (Ekman 1971, p. 251-252)	Colour (cf. (Jonas-Kaite & Mohr 2025))	Our rendition
Anger	“Brows pulled down and inward,” “eyes may appear squinting,” “lips tightly pressed together”	Red	
Disgust	“Brows drawn down but not together,” “[l]ower eyelids pushed up and raised, but not tensed,” “upper lip pushed up by raised lower lip”	Green	
Fear	“Raised and drawn together brows,” “[e]yes opened, tension apparent,” “[m]outh corners drawn back, but not up or down; lips stretched; mouth may or may not be open”	Purple	
Happiness	“No distinctive brow-forehead appearance,” “[e]yes may be	Yellow	

	relaxed or neutral in appearance,” “[o]uter corners of lips raised”		
Sadness	“Brows drawn together with inner corners raised,” “eyes may be looking downward,” mouth “closed with outer corners pulled slightly down”	Blue	
Surprise	“Raised curved eyebrows,” “[w]ide opened eyes,” “[d]ropped-open mouth”	Orange	

**Table 1.** Designs of our emojis representing six basic emotions, and the research on which the designs are based. Note that Ekman (1971) identified some variability within the human facial expression of an emotion. The facial features here are those which could be best represented as an emoji. The colours were selected from the systematic review of Jonauskaite and Mohr (2025), and are shown at 50% opacity for improved contrast.

Each emoji was paired with a colour commonly associated with the emotion the emoji represented (cf. Table 1). We based our colour choices on the systematic review by Jonauskaite and Mohr (2025). However, not all colours were suitable for Emoji Lantern. We took two criteria into account, when choosing the colour from the dataset. Firstly, a colour had to uniquely correspond to an emotion. A greater number of articles reporting an association implied a stronger association overall. We therefore assigned the colour with the strongest association first, before assigning the next colour from the remaining set. Secondly, because we intended to display the colours using LED lights, the colours had to be discriminable by hue. Therefore, the colours black, brown, grey, and white were not considered.

Applying these criteria, we derived emotion-colour pairings (anger-red, disgust-green, fear-purple, happiness-yellow, sadness-blue, surprise-orange). For the technical implementation, we obtained RGB values from the CSS Colour Module Level 3 specification (W3C 2022), which outlines numerical values corresponding to colour names.

## 4 Implementation

Emoji Lantern consists of two Ambient Interfaces, each measuring 20 cm<sup>3</sup>. The internals are a basic structure as well as a mechanism for the shadow projector. The mechanism of our shadow projector differs considerably from the mechanism of Raudanjoki *et al.* (2020) as it was not possible to accommodate a sufficiently large disc within the available space. Instead, our mechanism consists of a hexagonal prism which uses the space more efficiently. The prism is rotated by a 28BYJ-48 stepper motor through a gear. Each lateral face of the prism shows a different emoji, printed onto a small transparency.

RGB LED light strips are attached to the basic structure, which was 3D printed with the Geetech i3 filament printer. The mechanism for the shadow projector

was 3D printed with the Anycubic Photon Mono 4 resin printer. Each Ambient Interface is controlled by an Arduino Uno R3 microcontroller. Serial communication is used for communicating between the microcontroller and a computer running a client application. The client application communicates with a server application over the internet via WebSockets. The client and server applications were implemented with Node.js 22.21.0.

## 5 Usage Scenario

Typical usage scenarios are that one user sends an emotion to a significant other. The recipient can then reply by also sending the same emotion or a different one. Since the system does not allow for any real communication or meta-communication, we envision pairs of users who play around with the system and then agree how they want to use the system. The system allows for maximal flexibility. For instance, if one person is sending a sadness emoji, some pairs might prefer to reply with the same emoji for sharing the emotion, while other couples might prefer to send a happy emoji to cheer the sad person up.

## 6 Conclusion

Emoji Lantern allows users to share emotion cues, consisting of a projected emoji paired with coloured ambient light. It takes advantage of the physical environment (cf. (Gross 2003; Wisneski *et al.* 1998)) and facilitates Connectedness between geographically separated users (cf. (Ijsselsteijn *et al.* 2003)). In the process, we designed original emojis, corresponding to six basic emotions (based on (Ekman 1971; Ekman 1978; Ekman 1992; Ekman *et al.* 1971; Jonauskaite & Mohr 2025)).

Our work is not without limitations. The projection is less visible in brightly lit environments. While our concept was based on known user needs identified in previous research, our work would greatly benefit from a thorough evaluation and user feedback. Future work could also focus on the evaluating our emoji designs.

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