A Remote Collaboration System with Empathy Glasses

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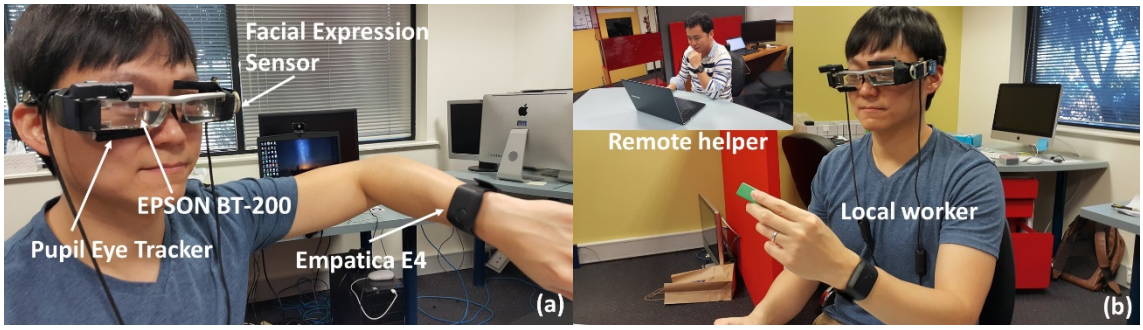

Figure 1: (a) Hardware (b) Collaboration between a remote helper and a local worker

ABSTRACT

In this paper, we describe a demonstration of remote collaboration system using Empathy glasses. Using our system, a local worker can share a view of their environment with a remote helper, as well as their gaze, facial expressions, and physiological signals. The remote user can send back visual cues via a see-through head mounted display to help them perform better on a real world task. The system also provides some indication of the remote users face expression using face tracking technology.

Keywords: Remote Collaboration, Empathy, Gaze Tracking, Facial Expression

1 BACKGROUND

In 1956, Alfred Adler defined Empathy as "seeing with the eyes of another, listening with the ears of another, and feeling with the heart of another" [1]. We have been developing a remote collaboration system with Empathy Glasses, a head worn display designed to create a stronger feeling of empathy between remote collaborators (see figure 1). To do this, we combined a head-mounted see-through display with a facial expression recognition system, a heart rate sensor, and an eye tracker. The goal is to enable a remote person to see and hear from another person's perspective and to understand how they are feeling. In this way, the system shares non-verbal cues that could help increase empathy between remote collaborators. In this paper, we describe the prototype we have developed and the user experience for attendees of the ISMAR 2016 conference.

2 RELATED WORK

Our research is based on earlier work in Affective Computing [2], remote collaboration [3] and wearable computing [4]. Since Picard developed the concept of Affective Computing [2], many researchers have created computer interfaces that detect emotion using facial expression, voice, physiological cues, and so on. Calvo and D'Mello [5] provide an excellent summary of various methods for detecting affect, showing that facial expression tracking is becoming a reliable way of detecting a user's emotions. For example, our AffectiveWear glasses used photo reflective sensors in glasses to reliably recognize some facial expressions in an unobtrusive manner [6]. However, this research typically focused on recognizing and responding to a single user's emotional display and not on creating a shared experience between several users.

Our research is the first to combine: (1) wearable facial expression sensing hardware, (2) eye tracking, (3) a head worn camera, (4) a see-through head mounted display and (5) physiological sensor monitoring, with a focus on improving remote collaboration. It is particularly important because it enables the sharing of implicit non-verbal communication cues (e.g. facial expressions, gaze, heart rate) that aren't normally available in interfaces for remote collaboration. This means that the system can enable richer communication than ever before.

3 COLLABORATIVE SYSTEMS WITH EMPATHY GLASSES

Our system consists of two components, (1) wearable hardware and see through display that captures and sends the wearer's viewpoint, gaze, heart rate and facial expressions and displays pointing cues from a remote helper, and (2) a remote desktop interface where the information sent is viewed by a remote helper and he/she can provide pointing feedback back to the local user's see-through display. The remote interface also captures the face expression of the remote helper and shares it to the local user.

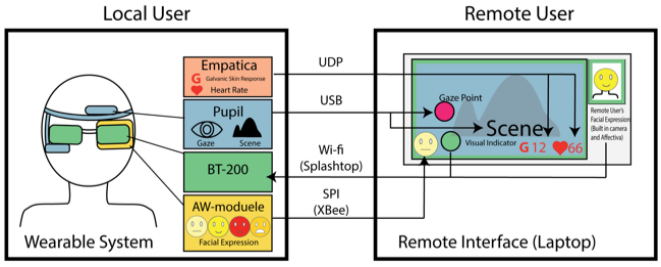

Figure 2: System Diagram

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The wearable system combines three hardware systems; (1) a Pupil Labs eye-tracker[1], (2) the AffectiveWear (AW) facial expression tracker [6], (3) the Empatica E-4 wrist worn heart rate monitor[2] and (4) the Epson Moverio BT-200 head mounted display[3]. Together these systems allow the local user's view, gaze point, heart rate and facial expression to be sent to a remote user, and virtual cues from the remote user to be sent back. Figure 2 shows how the components are connected.

Pupil Labs provides an open source platform for eye tracking that uses two cameras: an eye camera to track the user's right eye gaze and a head worn camera (HWC) to capture the user's view. The camera views are sent via USB to a desktop computer that runs the eye-tracking software.

The AffectiveWear (AW) module uses a photo reflective sensor array to recognize the facial expressions of the wearer. It consists of eight photo-reflective sensors taped to a left lens of Epson BT-200 HMD (see figure 3). Sensor input is fed into an Arduino module that identifies four facial expressions (Neutral /Positive /Negative /Surprise) with over 90% accuracy, based on the skin deformation measured by the sensors. This is then wirelessly sent to the remote helper. See [6] for more details.

AffectiveWear Sensors *View from outside glasses*

Figure 3: AffectiveWear Module

The Empatica E-4 wrist-worn device is used to capture the user's heart rate and galvanic skin response (GSR), and then wirelessly transmit that to the remote helper's user interface. The heart rate and GSR are sampled at 1 Hz.

Figure 4: Remote Helper's User Interface

The hardware is connected to a laptop computer that has an interface for the remote helper (see figure 4). The interface shows a live view from the local user's HWC, as well as icons showing their heart rate, GSR, and current facial expression. The local worker's eye gaze information is also shown (the red dot in figure 4), allowing the remote helper to know where they are looking.

The remote helper's user interface provides two types of feedback back to the local worker; (1) mouse input, (2) facial expression. The remote helper can use their mouse to move a pointer on the screen. The Affectiva software[4] is used to track the remote helper's facial expression and displays it on the user interface. Affectiva uses face-tracking software with camera input from the laptop computer to identify seven different emotional states (anger, contempt, joy, sadness, disgust, fear, and surprise).

The remote helper's screen view is shared back to the local worker and is shown in the BT-200 display, enabling two-way communication. Overall, the system allows the remote helper to see the local worker's workspace, their facial expression, gaze point, and physiological data. Similarly, it allows the local worker to see where the remote helper is indicating and their current facial expression. Thus the system supports the use of rich communication cues for remote collaboration.

4 The User Experience

For ISMAR we will develop a remote collaboration system with the Empathy Glasses. The demo will be a fixed experience where the person wearing the Empathy Glasses sits in a separate area from the remote helper, behind a screen. On the table in front of the local worker, there will be some real items designed to cause an emotional response, such as a cute toy, scary spider, timed puzzle, wooden blocks, wind-up Jack-in-the-box, and other objects. The local worker will be able to play with these items together with the remote helper, exploring which item they enjoy the most. The remote helper will know exactly which object the local user is looking at, and will be able to use a virtual pointer and audio cues to communicate back with them.

Overall, this experience is designed to show that our system can significantly improve remote collaboration by using technology that can provide richer communication cues than just audio and video. It will enable ISMAR 2016 attendees to have their first experience with a remote collaboration platform that supports empathy based communication.

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