An Exploratory Social-Emotional Prosthetic for Autism Spectrum Disorders

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Abstract

We describe a novel wearable device that perceives and reports on social-emotional information in real-time human interaction. Using a wearable camera and other sensors, combined with machine perception algorithms, the system records and analyzes the facial expressions and head movements of the person with whom the wearer is interacting. We propose the application of the social-emotional prosthetic to assist the growing number of individuals diagnosed with Autism Spectrum Disorder (ASD) in perceiving communication in a natural rather than a structured environment, bootstrapping their ability to learn and develop in social settings. The wearable device is a novel exploratory platform for researchers to gain a better understanding of social-emotional communication, enabling new kinds of measurements and interventions that may also help advance the theory of Autism.

Social-emotional intelligence is fundamental to the social functions that we take for granted, enabling us to take account of others' interests in conversation, empathize with others and persuade them to change their beliefs and actions [1]. As an example of where social-emotional communication breaks down, consider the case where you are in a dialogue and your conversational partner converts it to a monologue, showing no awareness of your subtle but increasingly frequent expressions of disinterest, or less subtle expressions of dissatisfaction, or even overt gestures of looking at your watch or the exit. When people cannot perceive and understand social-emotional cues such as facial displays of disinterest or dissatisfaction, then they are hindered in their ability to decide when to wind down the conversation. Social-emotional skills also play a key role in the processes underlying decision-making, perception and memory [3].

People diagnosed with Autism Spectrum Disorder (ASD) are thought to have deficits in social-emotional intelligence skills [1]. These deficits are characterized by a reduced ability to regulate social interaction, difficulties developing peer relationships, reduced signs of being empathic as shown by deviant responses to other people's emotions, and a weak integration of social-emotional behaviors. Persons with ASD also may exhibit atypical autonomic nervous system patterns [5], some of which can be monitored through skin-surface sensors such as a pair of electrodes and small circuit that measures skin conductance.

Bringing together and expanding upon recent advances and methodologies in three key scientific and technical areas—affective computing, wearable computing and real time machine perception, we are developing a novel wearable device that analyzes social-emotional information in human-human interaction. Using a small wearable camera and other sensors combined with machine vision and perception algorithms, the system analyzes the facial expressions and head movements of the person with whom the wearer is interacting. The system builds on and extends the work of el Kaliouby [6] – a computational model for the inference of affective-cognitive mental states from head and facial displays in a video stream in real time. We are also exploring the integration of skin conductance sensors, previously used in a wearable system to index and set aside video that co-occurs with measurable physiological changes [4].

We propose the use of the wearable platform as an exploratory and monitoring tool for people with ASD. While the signs of social-emotional interaction deficits are well documented in ASD, most are qualitative. For instance, it is well documented that children with ASD make less eye contact and seem to avoid face or eye contact altogether, which may affect their ability to learn and develop in social settings. It is less clear how exactly face contact is measured and what constitutes normal (too little face contact often feels like we are not connecting well with the other person, while constant eye contact makes us uncomfortable). The wearable platform is well-suited to recording a rich corpus of natural face to face interactions, which combined with machine perception algorithms can help identify the spatio-temporal features of a social interaction that predict how an interaction is perceived.

Finding an objective set of features to describe an interaction has favorable implications for automating some aspects of monitoring the progress of people with ASD with respect to social-emotional interaction, and for evaluating the effectiveness of alternative social skills development and behavioral therapies.

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