Smart Eye Wear to Recognize and Impact Affect in Real Life

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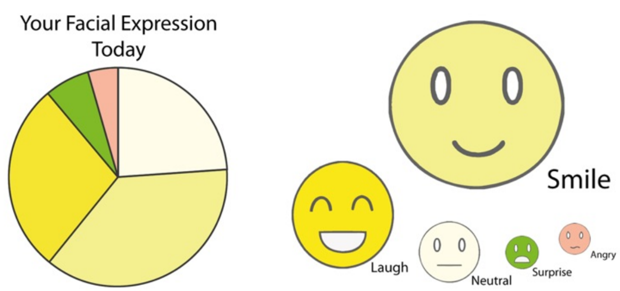

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Abstract
We present the concept of using eye wear to recognize and ultimately impact the emotional state of a person in this position paper. Eye Wear Computing ,as a fairly novel computing paradigm, has potential especially in affect recognition. Eye glasses are an established means to augment us humans. Given we can build smart glasses in a similar form factor, the position is perfect for sensing and to give user feedback. We outline the sensing potential of smart eye wear, discuss our initial efforts to recognize mental load and facial expressions using eye wear and finally give an outlook on the future application space.

Author Keywords
Emotion Recognition; Smart Eye Glasses; Eye Wear Computing

ACM Classification Keywords
H.5.2 [User Interfaces]: Input devices and strategies.

Introduction
Although the concept of affective computing is around for a couple of years and the researchers gain more and more insights on the impact of emotions in relationship to our wellbeing, intelligence etc., we have not seen real life affect detection. Also potential advantages about quantifying our affective state are largely unexplored.

Figure 1: The Affective Wear Prototype

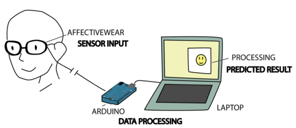

Figure 2: System Overview

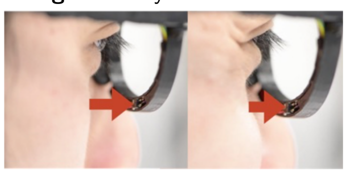

Figure 3: Deformation due to expression change.

Towards the end of assessing a persons affect, we present affective wear, eye wear to recognize facial expressions. As facial expressions are related to our emotional state, we see it as a first step to recognizing affect in realistic scenarios. Our eye wear enables the recognition of 7 expressions: neutral, disgust, angry, smile, laugh, sad, and surprise. This paper is an extension of our work for Siggraph Emerging Technologies and the UbiComp demonstration [5].

In the following, we discuss our approach using eye wear computing for affect recognition, discuss the current prototype limited to facial expressions, outline how to expand it for more general emotion detection and finally mention potential application cases as well as impact affect.

Approach

We believe one of the enabling technologies for affect recognition in real life is eye wear computing. The emerging field of eye wear computing is perfect for affect recognition, as the head is a natural position for sensing due to the human physiology (most of or senses,as well as the brain, are located there). The remaining problem is social acceptance, yet with smaller and smaller PCBs, sensor and actuators we believe we can now build smart glasses that are not so different in looks from normal eye wear, making them acceptable from a fashion and wear comfort perspective for the general public. [1, 3].

Recognizing Facial Expressions in real life

We presented already an initial prototype of affective wear, using skin deformation caused by muscle movement to detect facial expressions(see Figures 1 and 2). The deformation of the face skin is indicative of the facial expression a user does. We use photo reflectors to detect this deformation (distance between frame and skin, see Figure 3).

For the first prototype we use 8 photo reflectors arranged on the eye glasses. Affective wear has 2 distinct advantages over other systems: first, it's low cost (only photo reflective sensor), second it's simple, the processing needed to interpret the readings is minimal, no elaborate feature extraction or so needs to be done.

We performed an initial test on 2 users. Asking them to perform the 7 expressions, each expression 10 times, showing them pictures of people doing these expressions as start. Using a user-dependent recognition (Support Vector classifier) and a With 8 sensors, the accuracy of categorizing 7 facial expressions becomes 90%.

Modalities to Explore

There are a couple of sensor modalities related to cognitive or mental states, we want to explore in addition to the presented photoreflectors for facial expressions.

Eye Motion Analysis

Eye gaze can give a lot of information about the users mental state (e.g. interest, fatigue). There are optical systems as well as electrode-based systems (Electrooculography, EOG). The problem with optical systems is that battery run time is low (hard to get over a day) and processing is substantial. EOG on the other hand is low cost and battery preserving, however it's hard to associate the eye movements with scene images and the noise level in the recording is higher (especially when the electrodes are not taped to the skin).

For our purposes, EOG seems currently the more viable option, as it is low-cost, can be integrated easily in a glasses frame and can work over a whole day of recoding.

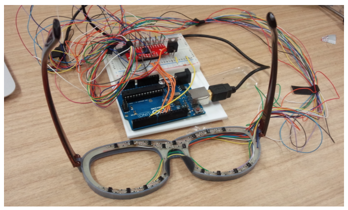

Figure 4: Second Prototype to evaluate photo refelctor placement.

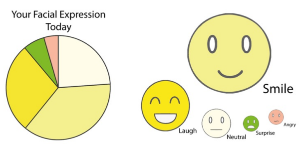

Figure 5: Mockup: Summary of Facial Expressions for a day.

Figure 6: Mockup: Facial Expression Map

Nose Temperature
A very interesting low cost, additional sensor modality is nose temperature. There are correlations with nose temperature change related to cognitive load, empathy etc. [6]. Kunze et al. showed also a relation of nose temperature change and interest [4]. However, the studies so far have either very small sample sizes or are conducted in a clinical, more controlled environment. It might be challenging to deal with environmental changes etc.

Summary
Of course, there are also the more obvious physiological signals, like heart rate and galvanic skin response. Yet, it seems they are difficult to interpret on their own. Also we can rely there on extensive related work regarding their relation to affect. Therefore, we want to focus on eye movements and nose temperature for future exploration.

Usage Scenarios

In the following we discuss a couple of application cases we find interesting in terms of affect detection.

Happiness Map
Given we can get emotion recognition in realistic settings, one simple way to apply it is to combine the emotional state with location. People can search for the "happiest" place to live or work, can get an overview of how events and policies change the affect state of a region or country. This application can already be implemented with Affective Wear, we can show the facial expressions prevalent in a particular location or region.

Collaborative Media Tagging
Facial expressions or later emotions can be used to enhance content. If a lot of people read a book or watch a video with their facial expression recorded, the content can be indexed and made searchable, e.g. "I want to read a book that makes me smile in around half an hour."

Interactive Design Feedback
Content creators could also get a better grasp on their techniques making story telling more effective (e.g. what works to surprise a reader/watcher and what does not work).

Towards Impacting Emotions

This is a very delicate problem, as people should feel empowered by technology not influenced or even oppressed. Still given the rise of depression and other mental illnesses related to an emotional imbalance, we believe people can benefit from devices that can alter their emotional state. Yet, these influences should be aligned with the user's long term goals (not influencing them in "unwanted ways").

Tsujita et al. outlined a basic example, we can increase the happiness of people by making them smile more [8]. Applying James Lang Theory of Emotion (e.g. "if you smile more you will feel happier"). Along those lines, we wonder what happens if we apply technologies to change some of the symptoms of mental disease. For example, a depressed person usually talks little with others and stays in bed longer (is not physical active). Now if a system successfully encourages this person to more social interactions or more physical activity, will this change also the mental state of the person? We need to evaluate the possibility, if so it might be a very simple way to deal with some mental illnesses. Of course, the proposed solution seems trivial and will not work in every case (e.g. need for personalization). However, it can be a promising first step.

Related Work

There are a number of works related to automatic facial expression detection in computer vision [7]. The general approach to analyze facial expressions consists of three steps:

face acquisition, facial data extraction and representation, and facial expression recognition. This approach proved the high accuracy of Facial Expression recognition. Overall, camera-based systems cannot analyze facial expressions in daily life due to placement and battery issues.

Several works show wearable systems that can recognize facial expressions in daily life [2]. Yet, these works focus on detecting only specific facial expressions. Our contribution is detecting various facial expression states and the usability in daily life. With our device, computing systems that will be everywhere in the age of IoT can tap into the rich set of information provided by nonverbal communication.

Conclusion and Future Work

Next we are working on an affective wear prototype using 12- 17 photo-reflectors around they eyes to evaluate which position and number of them is most effective. We are also working on incorporating the other sensing modalities (eye movements and nose temperature) for future experiments, moving away from facial expressions towards affect.

Acknowledgements

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