

OCOsenseTM Smart Glasses for Analyzing Facial Expressions Using Optomyographic Sensors

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Pervasive Computing

January 11, 2024



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Introduction

- The last decade has seen a rise in smart devices like watches, earrings, e-textiles, jewellery, wearable ECG monitors and eye-wears.
- It is envisioned that these wearables will not only be used for multi-modal high accuracy monitoring, but also, for biofeedback informed interventions and research and development.



Background and Motivation

- Most sensors measure arousal metrics, for example pulse-rate, electrodermal response.
- 2 Compared to other bodily cues, facial expressions are considered the richest source of emotional information
- 3 Facial expression-derived valence is highly dependent on context.
- 4 Therefore, continuous monitoring of facial activation merged with the users' activities, can offer insights to behavioral and emotion changes.
- It is within this backdrop that the OCOsenseTM smart glasses equipped with optomyographic (OMG) sensors come into play, to allow real-time monitoring of facial muscle activations.



Existing technologies that measure the activation of facial muscles



Figure 1: Electromyography

- 1 The defacto method; Electromyography (EMG)
- 2 Camera-based tracking of the zygomaticus major and corrugator muscles.
- 3 Two main challenges affect the above cited traditional techniques.
 - The first is the lack of generalizability
 - The conspicuous nature of these traditional techniques, therefore, making them ill-suited to be used as wearables.

Recent State-of-the-art Facial Wearables

- CapGlasses; equipped with face-mounted cameras. The main drawback of this device is that it suffers from electromagnetic interference, and it lacks immunity to different environmental conditions.
- Electrooculographic glasses; detection of facial activation and facial expression. However, it is limited by high sensitivity to head movements and low sensitivity to lower-face actions such as smiling.



Figure 2: CapGlasses



Description of OCOsense Smart Glasses





OCOsense Smart Glasses: Size Weight and Power (SWAP) Requirements



- Notably, the high sensitivity of optomyographic sensors to movements eliminate the need for an intricate filtering process to obtain a usable signal, avoiding computational expenses and detection delays.
- The combined data rate of various sensors, including seven OCO sensors, a 9-axis IMU, altimeter, and dual speech-detection microphones, is 2.9 kB/s. This rate is considerably lower when compared to camera-based facial expression recognition (FER) systems that ranges from 13.9 to 146.5 MB/s.

Validation of OCOSense Smart Glasses



Figure 4: Testing rig



Conclusion

- It is made up of seven optomyography (OMG) sensors, 9-axis IMU, a dual-speech detection microphone.
- **2** Each sensor is sampled at 50MHz, and the overall transfer data rate over the bluetooth protocol is 2.9kB/s.
- 3 Skin motion tracking resolution in the xy plane of $3.79 \mu m$.
- 4 Drawback the IR laser used used by OMG sensors is affected skin tone, makeup, perspiration.
- **5** This technology is for promising for advances in neuroscience and detection of strokes.

