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OCOsenseTM Smart Glasses for Analyzing Facial Expressions Using Optomyographic Sensors

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Outline

Introduction

1. The last decade has seen a rise in smart devices like watches, earrings, e-textiles, jewellery, wearable ECG monitors and eye-wears.
2. 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

1. 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.
5. 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

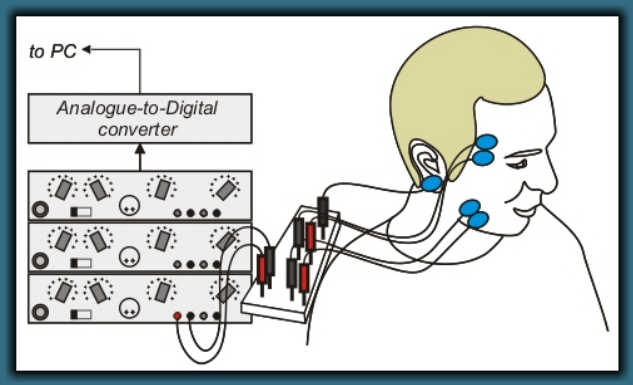


Figure 1: Electromyography

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

1. 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.
2. 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

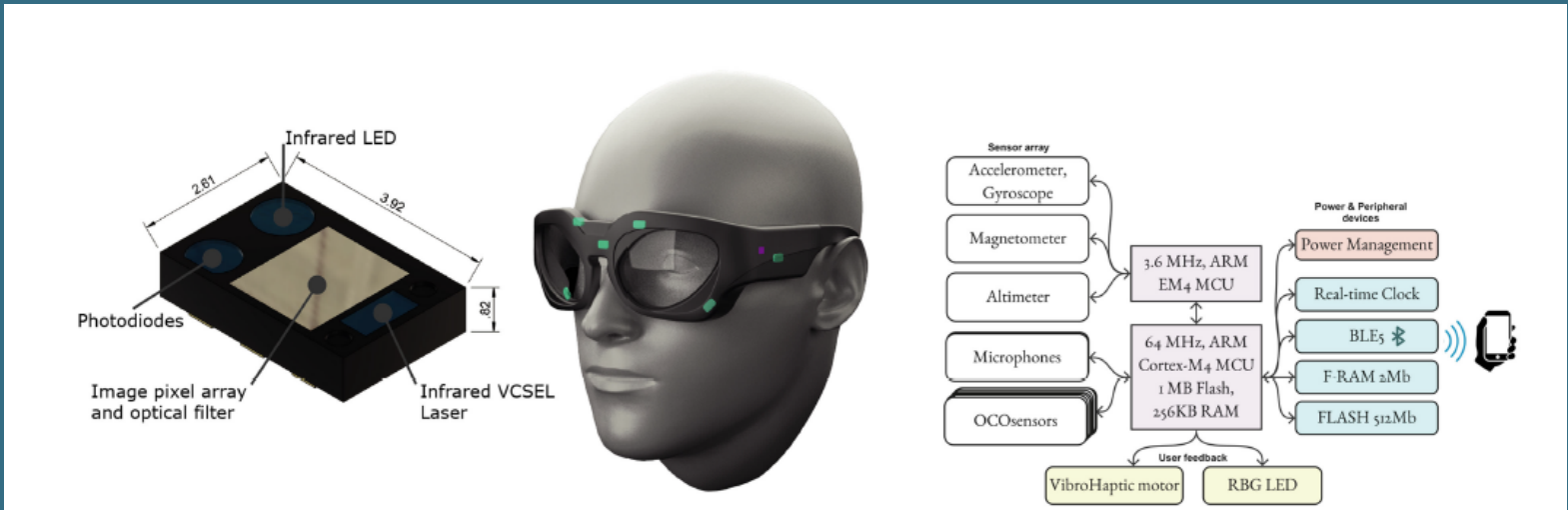
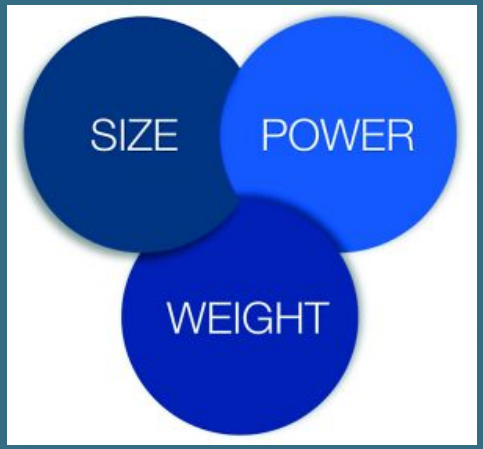


Figure 3: OCOSense Description

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



1. 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.
2. 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

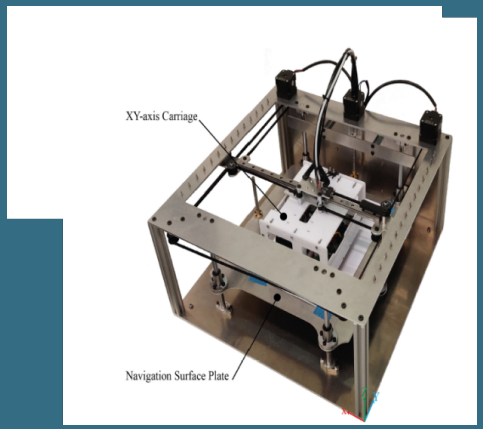
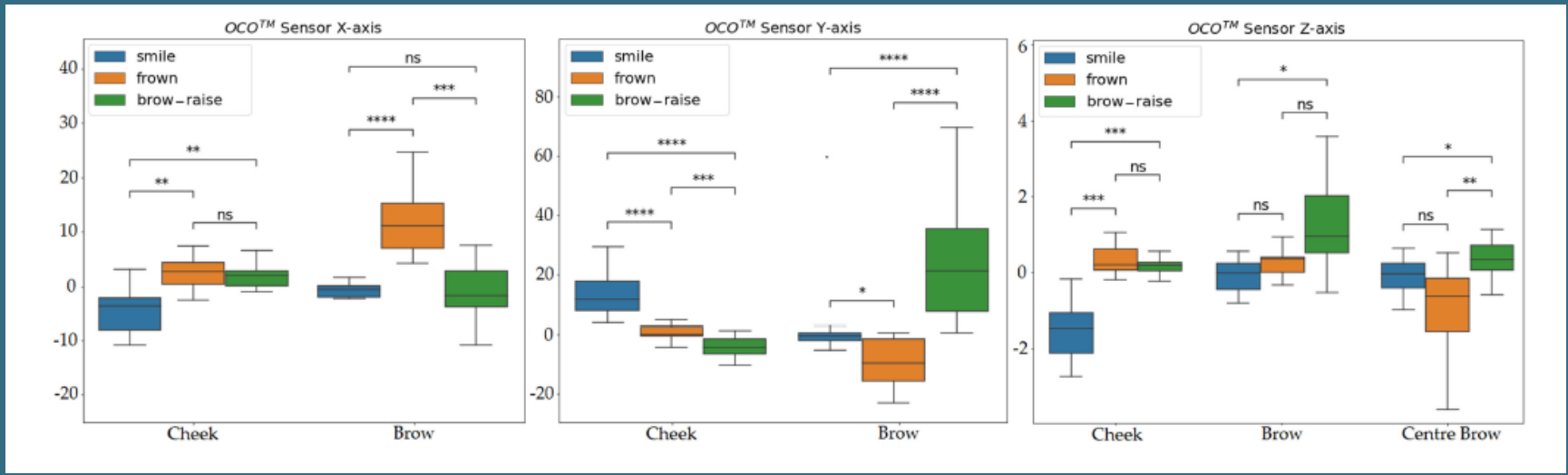


Figure 4: Testing rig



Conclusion

1. 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.