

Phonetic and Visual Characteristics of Cognitive Load

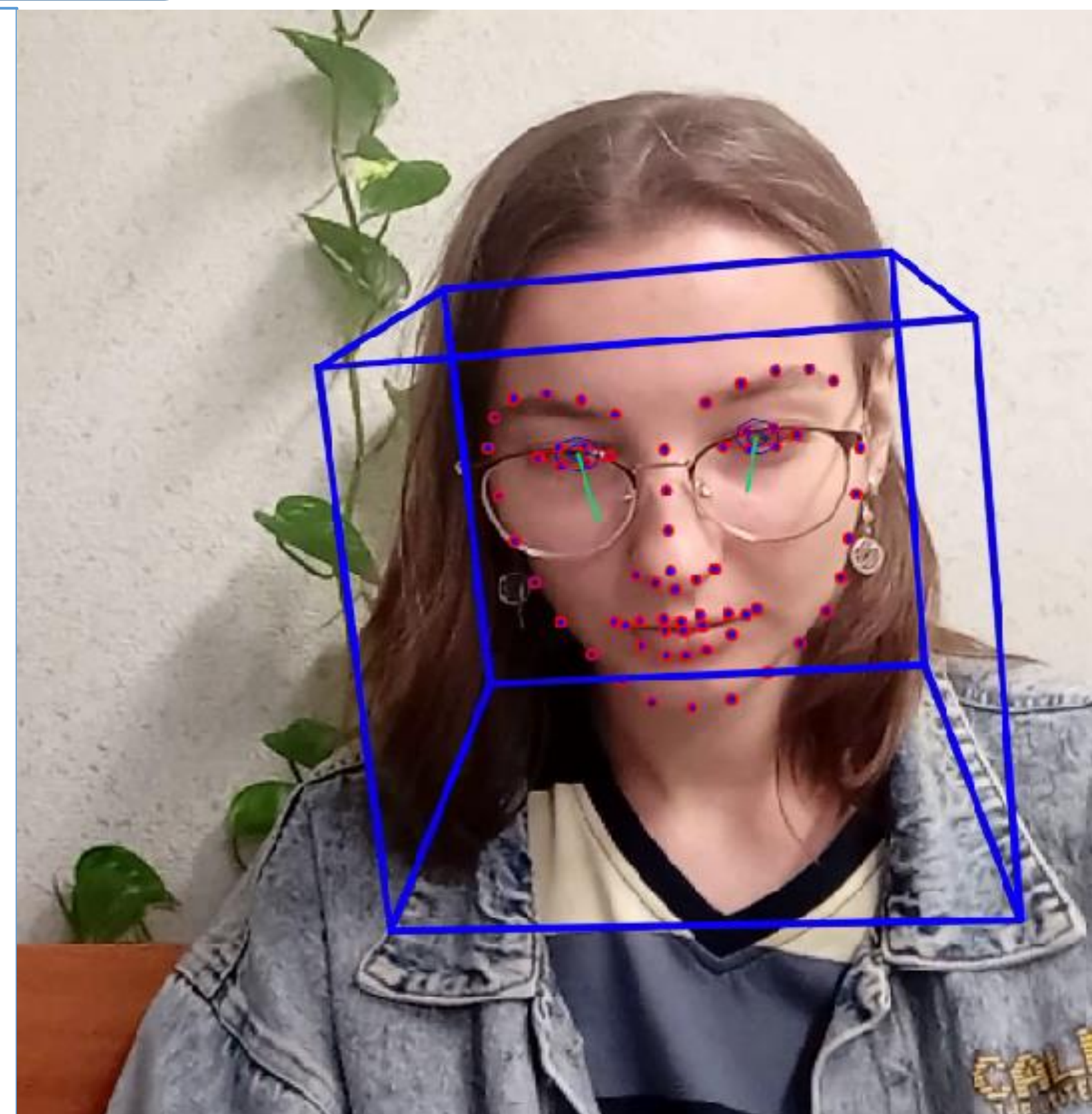
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Introduction

Cognitive load is the load on a person's cognitive system when performing a task. This paper analyses speech and facial features that are characteristic of cognitive load. Previous research revealed that cognitive load is associated with increasing fundamental frequency (F0), laryngealization, narrowing F0 range, changing articulation rate. Cognitive load can also be recognized using head pose, eye gaze and facial expressions.

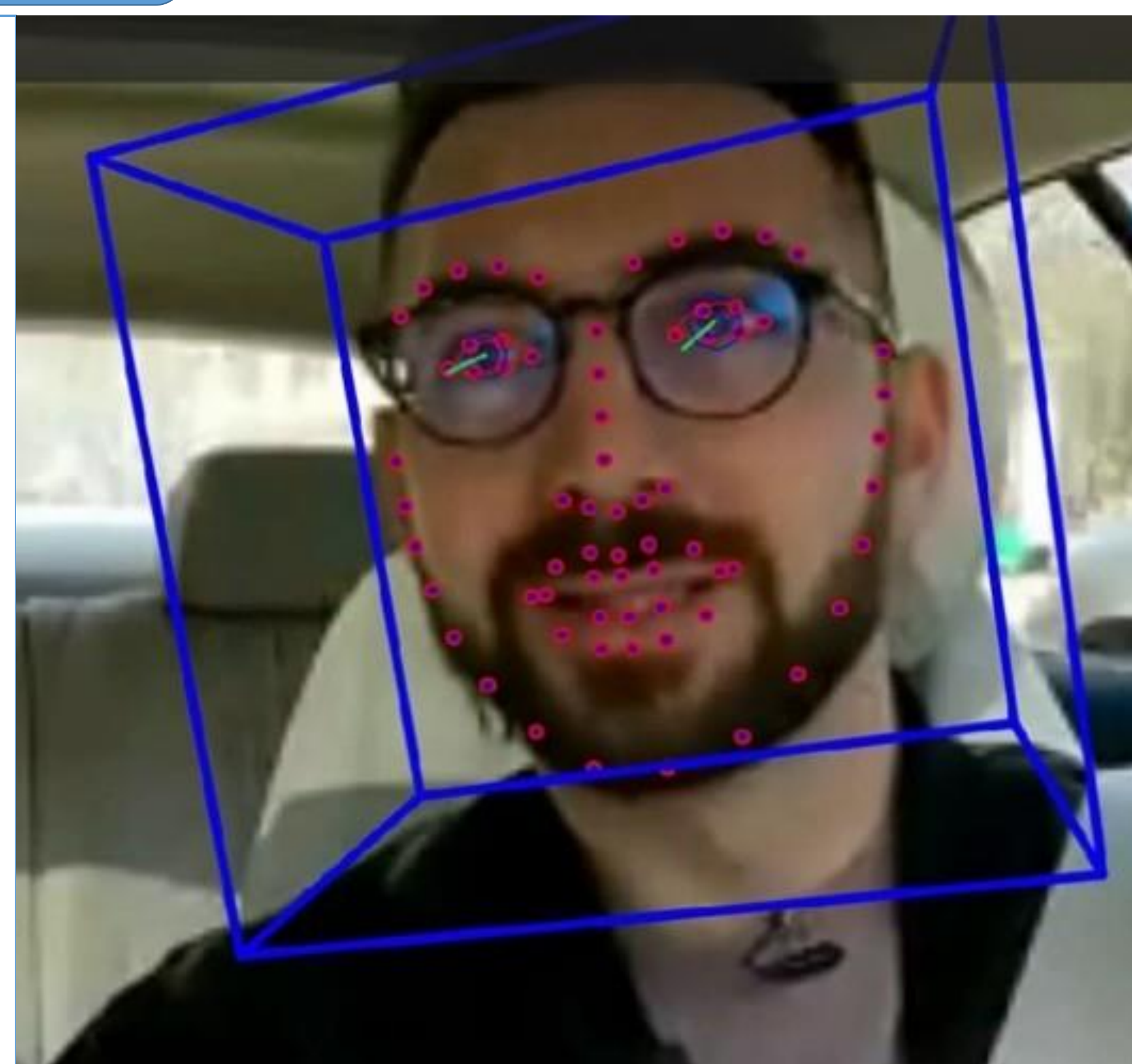
Experiment 1

- The participants played a driving simulator game and answered general knowledge questions simultaneously. Audio and videosamples were recorded.
- Action units (AUs) were obtained using Open Face 2.2.0. The sound files were transcribed using WEBMAUS Basic and Praat. Acoustic parameters were obtained using SpeCT scripts.



Experiment 2

- Three episodes of a talk show were studied. The interviewer was driving a vehicle and conducting an interview as a dual task.
- Action units were extracted from the video recordings using OpenFace 2.2.0. The sound files were transcribed using WEBMAUS Basic and Praat. Acoustic parameters were obtained using SpeCT scripts.



Results

- Under cognitive load the durations of both vowels and consonants increase while F0 range becomes narrower.
- Laryngealized segments also demonstrate higher duration under cognitive load.
- When speaking and driving simultaneously, which induces higher cognitive load, sound durations increased to a greater extent.

Table 1. The most frequent action units with cognitive load (averaged for both experiments).

Action unit number	Action unit name	Average frequency, %
AU14	Dimpler	69
AU05	Upper lid raiser	47
AU10	Upper lip raiser	38
AU04	Brow lowerer	37
AU45	Blink	32

Table 2. The most frequent action units without cognitive load (averaged for both experiments).

Action unit number	Action unit name	Average frequency, %
AU05	Upper lid raiser	58
AU10	Upper lip raiser	51
AU14	Dimpler	49
AU04	Brow lowerer	32
AU02	Lip corner depressor	31

- Regarding visual parameters, cognitive load can be recognized by muscle movements in the eye area and in the lip area. Dimpler (AU14), upper lip raiser (AU10) and brow lowerer (AU04) showed high frequency and intensity values in both experiments.
- Dimpler was the highest and the most intensive characteristic in the majority of cases.
- Inner and outer brow raising were more frequent in real-life driving conditions while performing a dual task compared to the simulator experiment. Thus, these facial gestures could be typical of higher cognitive load.