Affective Categorization Using Contact-less Based Accelerometers

Speaker:
Refael Shamir
Founder and CEO of Letos
Presentation Outline

Motivation
- Driver monitoring in the new age

Background and Definitions
- First steps to understanding Affect Categorization

Technology Review
- Facial Expressions
  - Eye Tracking
- Voice Recognition
- Wearable Monitoring
  - EEG, ECG, GSR, PPG...
- Sentiment Analysis

Current State of the Art - Gap and Challenges

Introducing Letos - How, When and Where
Misconception?
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Motivation
Motivation

– There is a growing debate on the tracking of in-cabin monitoring (e.g. tracking alertness)

– Using gaze estimation is only part of the solution
  – Keeping eyes on the road, does not proclaim alertness level with a good confidence

– Need to track engagement level of the driver at all times
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Background and Definitions - Cnt’d

Affective Computing: Picard first introduced the term “affective computing” in 1995, as a mean to evaluate different emotions, or expressions, from a computer perspective.
The Dimensional Affective State Model

Arousal (Y-axis) - Indicates excitement/engagement level

Valence (X-axis) - Indicates pleasure/comfort level

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<tr>
<td>Sadness</td>
<td>III</td>
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<tr>
<td>Anger</td>
<td>IV</td>
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<tr>
<td>Surprise</td>
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<tr>
<td>Disgust</td>
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<tr>
<td>Relief</td>
<td>II</td>
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Tools for Evaluating Affective States
Suggested Prototype for Auto-Classification

Input Source

Pre-Processing & Object Detection

Feature Extraction

Post-Processing

Feature Selection

Training Model

Output

Classifier
Ekman’s Model

Paul Ekman argues that there are 6 basic facial expressions which are uniquely distinguished from one another, that have a relationship with an emotional state (Ekman, 1972)

These set of emotions, according to Ekman, are being expressed across humans, regardless of age, gender, race, or culture
Facial Expressions
Feature Extraction for Affect Classification

**Geometric Features**
- Detecting the face (shape/size)
- Detect cue points (lips, eyebrow)
→ Categorize emotions based on relative position to the face

**Appearance Based**
- Detecting the face (shape/size)
- Texture layering (filters)
→ Categorize emotions based on extracted feature type
Technology Analysis

Capturing the duration of the emotion
0.5 - 4 seconds

Positive and negative differentiation

Spontaneous reaction (faking?)

Evaluating intensity level (arousal)

Can still be solved using a camera!

Confidence

Valence

Negative

Positive
Human Eye

Eyebrows

Eyelashes

Eyelids

Pupil

Iris

Sclera
How Sherlock Does It

bBHT158E0s?start=107&end=128
Pupillary Response - Explained

During rest, the eye’s pupil usually constricts, due to parasympathetic activity.

When presenting a stimuli, the eye’s pupil tends to dilate, due to sympathetic activity.

(Bradley, Miccoli, Escrig, & Lang, 2008)
References and Further Reading


Human Speech - Overview

– Speech is basically a stream of words spoken in a particular way

– In order to differentiate between different syllables the vocal cords vibrates, and sound is sequentially being filtered through the mouth and nose

– In general, speech is carried over an anchor frequency (which varies within different scenarios). This is often abbreviated as ‘F0’

https://www.youtube.com/watch?v=yxxRAHVafl
Speech Recognition - Background

Human speech can be modeled through differentiating what is being transmitted during the message, and what is its intended affect.

"That’s so funny"

"This upsets me"

"I’m so happy"

Primary  Secondary
Feature Extraction for Affect Classification

**Voice/Volume Level:**
Higher levels might indicate anger or fear

**Pitch:**
Usually, compared to the base frequency F0

**Speaking rate:**
Can indicate speaker’s confidence level

Generally, voice indicates merely arousal level
Speech to Text

Source: https://hacks.mozilla.org/2017/11/a-journey-to-10-word-error-rate/
Sentiment Orientation

Sentiment (or text) analysis can basically infer positive and negative - i.e. valence - opinions which people express either through voice or in writing.
Not So Fast...

- Not all expressions have a single meaning
  
  - e.g. "That’s so funny" - positive sentence; different meaning with use of tone (sarcasm)

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<tr>
<td>Terrible</td>
<td><img src="#" alt="Star Rating" /></td>
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</table>
Linguistics as a mean for Classifying Emotions

Guidelines:

“I’m happy that you’re here”

“This upsets me”

“That’s so funny”

Usage of bad language [Cursing, Insulting, Blaming, etc.]
References and Further Reading


3. Open source tool: https://sourceforge.net/projects/openart/. Open source project named openEAR (originated at TUM)

Different Types of Monitoring
Autonomous Nervous System (ANS)

Parasympathetic “rest and digest”

Sympathetic “fight-or-flight”

ANS - Continued

Sympathetic Nervous System activity:

Parasympathetic Nervous System activity:
Human Heart

Superior Vena Cava

Aorta

Pulmonary Artery

Pulmonary Vein

Right Atrium

Left Atrium

Mitral Valve

Pulmonary Valve

Tricuspid Valve

Right Ventricle

Left Ventricle

Aortic Valve

Inferior Vena Cava
Heart Rate Measurement

A person heart rate can be extracted through either an ECG, or a PPG (usually smart watches nowadays)
Heart Rate Variability

– Heart rate variability (HRV) is the variation of consecutive beat-to-beat (b2b) intervals
– It indicates the heart's ability to respond to stimuli such as breathing, exercise, stress, diseases or sleep
– Decreased with SNS; Increased with Parasympathetic
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Technology Overview
- Companies; Market; Use Cases

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Currently, most commercial products give merely a differentiation between Positive and Negative emotions.
Challenges

Self Assessment:

Multi-Modal Approach:

- Spontaneous; Unobtrusive
- Awareness
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Recognizing anonymously user emotional reaction within different scenarios
Solution

Advanced Machine Learning techniques for performing affective classification based on physiological signals

- 5 Emotional States
- ML/DL for Classifying Emotional States
- Complete Anonymity
Product - Features

- Contact-less single sensor solution
- Wireless Communication
- Heart Rate; Heart Rate Variability
- 1 Sample/Second
- Respiration Rate
Demonstration
Demonstration

Respiration Rate

Heart Rate
Ballistocardiography

Ballistocardiography is a non-invasive method based on the measurement of the body motion generated by the ejection of the blood at each cardiac cycle. It is one of the many methods relying on detection of cardiac and cardiovascular-related mechanical motions, such as phonocardiography, apexcardiography, seismocardiography, kinetocardiography to list just a few.

http://people.csail.mit.edu/balakg/pulsefromheadmotion.html
Thank You

www.letos.me
info@letos.me