DES535
Ubiquitous Computing

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Google Classroom Code : pcwnf5t

Affective Computing

Module VII

What is Affective Computing? [Contd…]

- Identify and Explain the Emotions as Physical and/or Cognitive

“The Wheelchair Scenario Rafe's friends always describe him as a happy person. He likes to play tennis and finds great enjoyment in watching the top professionals play the game.

After watching his favorite player win in the semifinals of a grand prix tennis tournament, Rafe contentedly stood in line under a hot August sun waiting to get a cool drink. As the glow of his vicarious victory faded, the heat and humidity became more and more oppressive.

Suddenly, Rafe felt a piercing pain from a blow to his lower back. Rafe turned rapidly with an angry expression and clenched fist. Rafe saw that he had been hit by Rebecca, a person with hemiplegia whose wheelchair had gone out of control and caused her to crash into Rafe and to spill her drink on her dress.

Rafe's understanding that the cause of his pain was an uncontrollable event that had embarrassed Rebecca immediately changed his anger to sadness and sympathy. Though still in pain, his happy nature surfaced, and he began helping Rebecca recover from the accident?”

What is Affective Computing?

- Affective computing is the expanding intersection between technology and emotion. It is characterized by the detection of and response to human feelings.
- Emotions are cognitive, emphasizing their mental component.
    - Understanding the situations that give rise to emotions
- Emotions are physical, emphasizing their bodily component.
    - Emphasizes the physiological response that co-occurs with an emotion or rapidly follows it.

Affective Computing, Picard

Physical Aspects of Emotion: Sentic Modulation

T*he emotional character is expressed by a specific subtle modulation of the motor action involved which corresponds precisely to the demands of the sentic state*.

—Manfred Clynes, in Sentics (1977)

- Sentic modulation, such as voice inflection, facial expression, and posture, is the physical means by which an emotional state is typically expressed, and is the primary means of communicating human emotion.
- Sentic modulation is natural, and usually subconscious.
- There are "basic" emotions, each of which has its own set of unique facial muscle movement patterns.

Physical Aspects of Emotion: Sentic Modulation [Contd…]

- Types of Sentic Modulation
  - Facial Expressions - “The social display of rules”
    - If you are to design a system for detecting emotions in this classroom vs those in the sports ground, would it the same set of facial expressions?
  - Vocal Intonation
    - Voice, of course, is why the phone tends to communicate affective information more accurately than email or a written letter
    - The challenge for affective computers is to understand “how” something is said over “what” is said or “who” said.
    - Vocal inflection is also important in applications where people and computers depend upon the use of synthetic voices

Physical Aspects of Emotion: Sentic Modulation [Contd…]

- Types of Sentic Modulation
  - Motor forms for expressions
    - A person can select an arbitrary motor output of sufficient degrees of freedom for expressing emotion.
    - Sentograph measures pressure along two degrees of freedom
    - Essentic form: There is a spatiotemporal form in art, music, movement, etc., with clear beginning and end, that embodies the emotional message.

Physical Aspects of Emotion: Sentic Modulation [Contd…]

- Types of Sentic Modulation
  - Physiological Responses

Apparent to others:

Facial expression

Voice intonation

Gestures, Movement

Posture

Pupilary dilation

Less apparent to others:

Respiration

Heart rate, pulse

Temperature

Electrodermal response, perspiration

Muscle action potentials

Blood pressure

Physical Aspects of Emotion: Sentic Modulation [Contd…]

- While Designing a Ubiquitous System for understand human emotion, what aspects will you consider for its real-world implementation and decreasing wrong predictions?

1. Intensity of the emotion;
2. Type of the emotion, e.g., there are many types of love;
3. How the state was induced, e.g., imagining a situation, watching a film, or being in the midst of a genuine conflict;
4. Social display rules, and whether the person was encouraged to express or suppress emotion.
5. Other factors: Mood, diet, medication, context sensing, etc.

Cognitive Aspects of Emotion

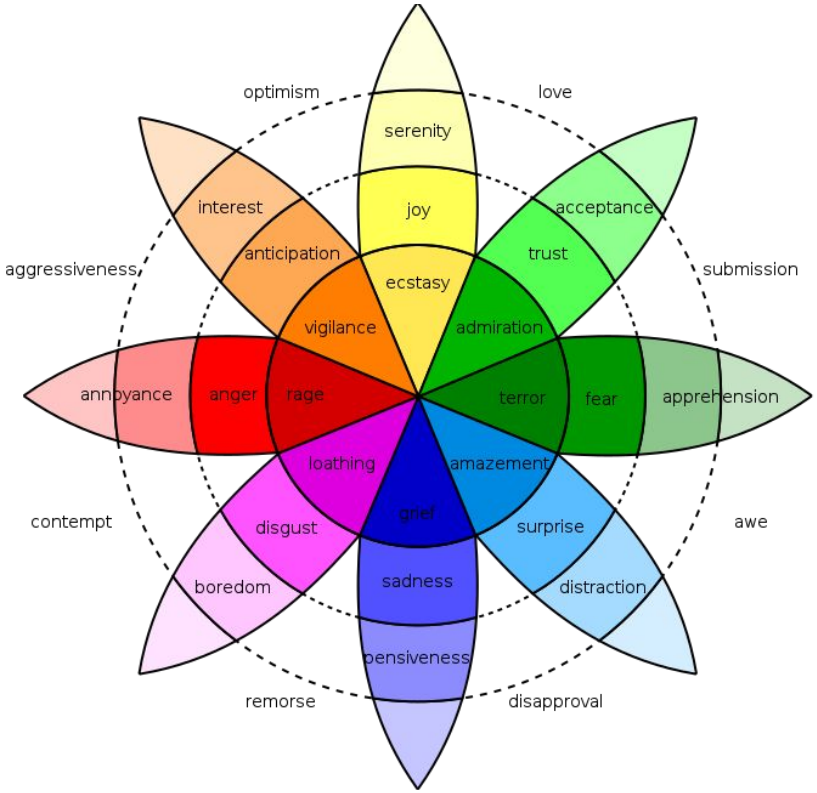
- "Cognitive" aspects like appraisal, comparison, categorization, inference, attribution, or judgment effects emotion.

- Primary and Secondary Emotions : There are certain features of stimuli in the world that we respond to emotionally first, and that activate a corresponding cognitive state secondarily

Affective Computing, Picard

Human Expressions and Emotions

Paul Ekman **six basic human emotions** (Contempt was added later)



Plutchik Wheel of **8 Emotions**

Micro expressions are brief, involuntary facial expressions, while macro expressions are longer-lasting.

| Image source : Internet

Human Expressions and Emotions : Action Units (AU)

Upper Third

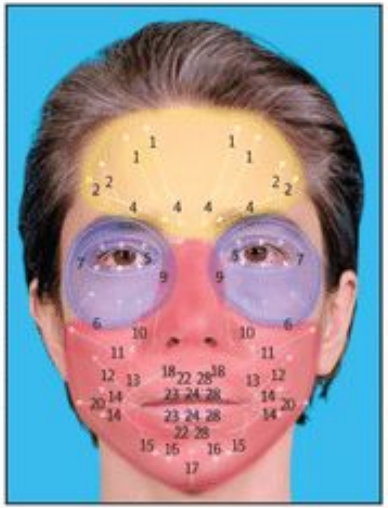
Action Units	Description	Associated Muscle
1	Inner brow raiser	Frontalis, pars medialis
2	Outer brow raiser	Frontalis, pars lateralis
4	Brow lowerer	Depressor glabellae, Depressor supercilii, corrugator

Orbital

Action Units	Description	Associated Muscle
5	Upper lid raiser	Levator palpebrae superioris
6	Check raiser	Orbicularis oculi, pars orbitalis
7	Lid tightener	Orbicularis oculi, pars palpebralis
9	Nose wrinkler	Levator labii superioris alaeque nasi

Midface + Lower Two Thirds

Action Units	Description	Associated Muscle
10	Upper lip raiser	Levator labii superioris, caput infraorbitalis
11	Nasolabial deepener	Zygomaticus minor
12	Lip corner puller	Zygomaticus major
13	Cheek puffer	Levator anguli oris



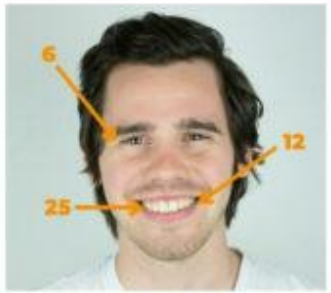
Midface + Lower Two Thirds

Action Units	Description	Associated Muscle
14	Dimpler	Buccinator
15	Lip corner depressor	Depressor anguli oris
16	Lower lip depressor	Depressor labii inferioris
17	Chin raiser	Mentalis
18	Lip puckerer	Incisivus labii superioris, incisivus labii inferioris
20	Lip stretcher	Risorius
22	Lip funneler	Orbicularis oris
23	Lip tightener	Orbicularis oris
24	Lip pressor	Orbicularis oris
25	Lips part	Depressor labii inferioris, orbicularis oris, relaxation of mentalis
26	Jaw drop	Masseter, relaxation of temporal pterygoid, relaxation of internal pterygoid
27	Mouth stretch	Pterygoids
28	Lip suck	Orbicularis oris

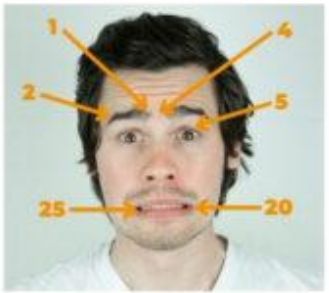
Image source : Internet

Human Expressions and Emotions :Facial Action Coding System (FACS)

Neutral



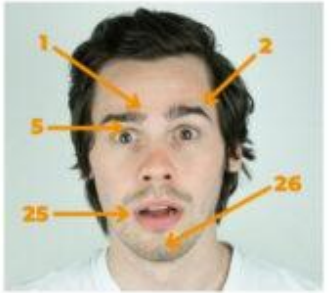
Happy



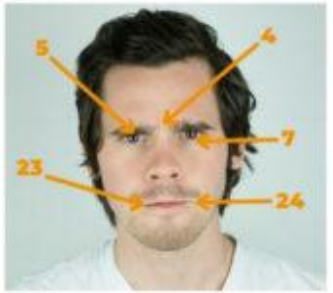
Fear

Sadness

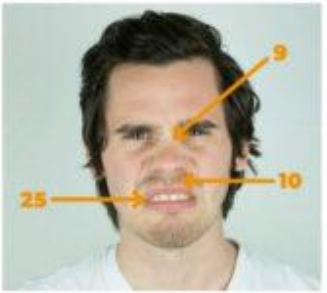
Contempt



Surprise



Anger



Disgust

1 - Inner Brow Raiser
2 - Outer Brow Raiser
4 - Brow Lower
5 - Upper Lid Raiser
6 - Cheek Raiser
7 - Lid Tightener
9 - Nose Wrinkle
10 - Upper Lip Raiser
12 - Lip Corner Puller
14 - Dimpler
15 - Lip Corner Depressor
17 - Chin Raiser
20 - Lip Stretcher
23 - Lip Tightener
24 - Lip Pressor
25 - Lips Part
26 - Jaw Drop

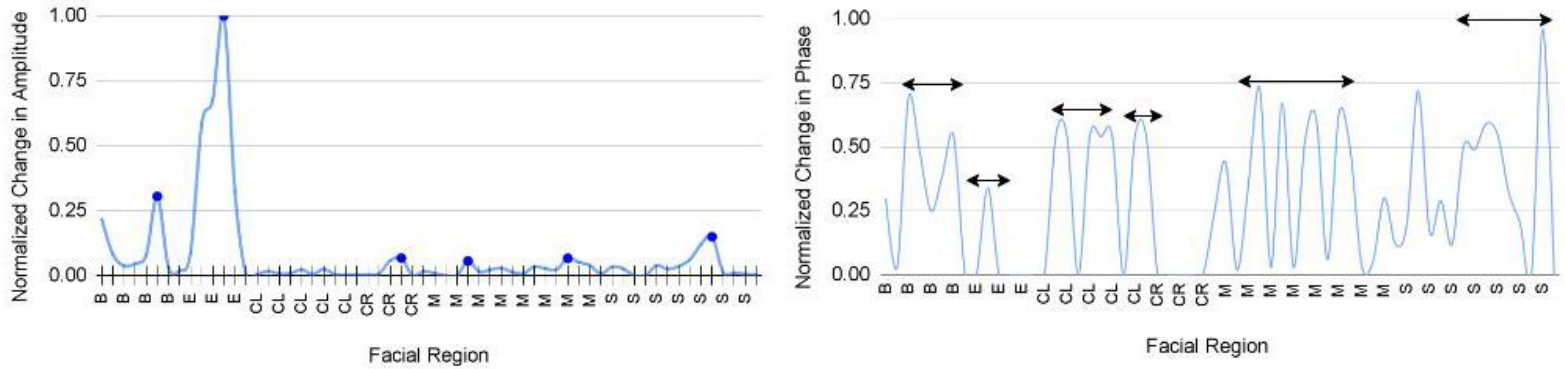
Image source : Internet

Case Study
ExpresSense: Exploring a Standalone Smartphone to Sense Engagement of Users from Facial Expressions Using Acoustic Sensing

Authors: Pragma Kar, Shyamvanshikumar Singh, Avijit Mandal, Samiran Chattopadhyay, Sandip Chakraborty
Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems

Opportunities And Challenges

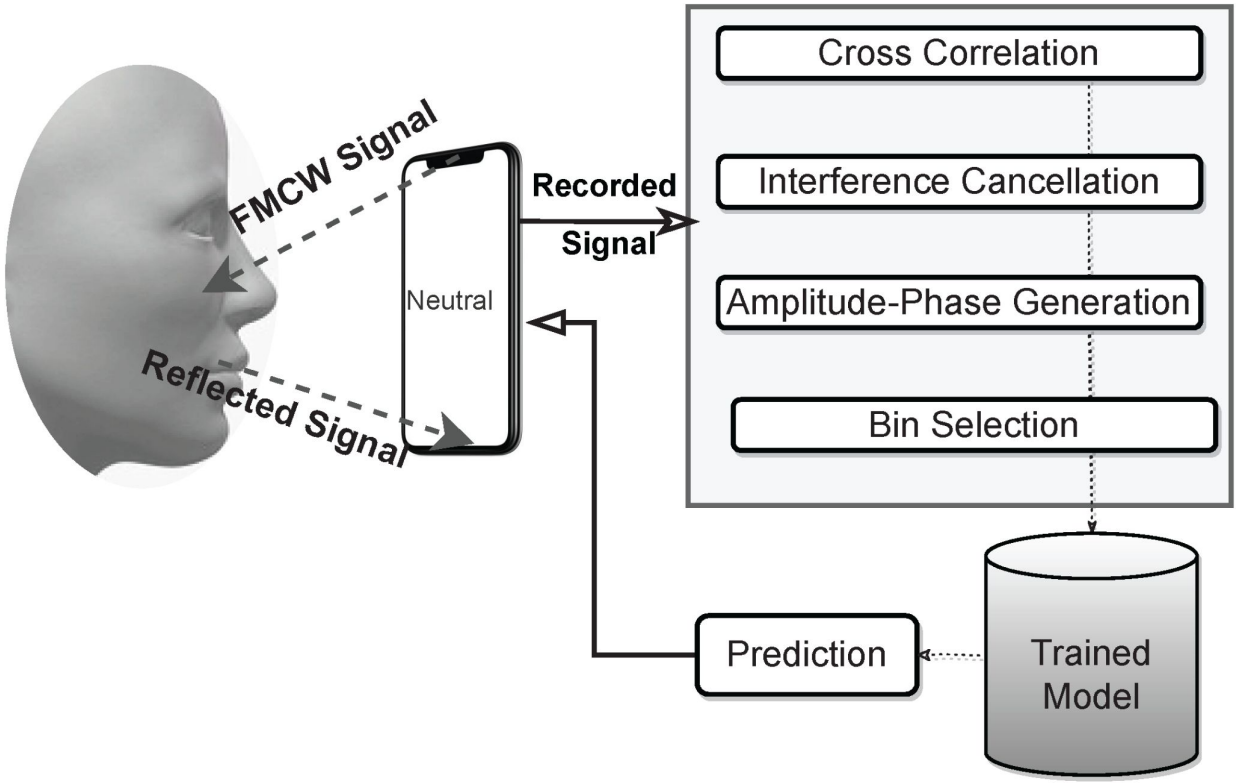
Raise eyebrows/frown (B), blink (E), raise left cheek (CL), raise right cheek (CR), move mouth region (left and right) (M), and smile (S)



Facial Muscles and Acoustic Feature Variation

- Supported Frequency Range is less than 20 kHz.
- Single Microphone
- Signal Fusion can cause severe interference

Overview Of ExpresSense



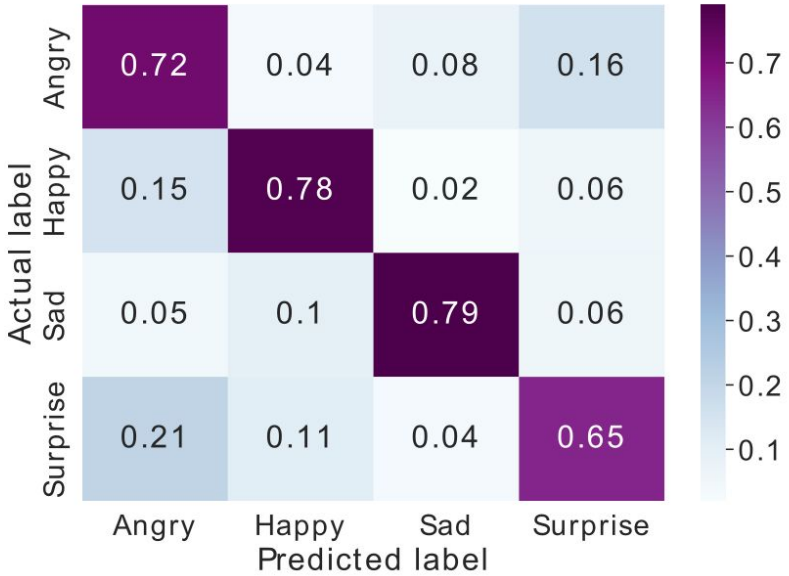
Overview of ExpresSense

How well can ExpresSense infer the four basic facial expressions of a subject in general?

Experimental Setup

- 10 participants (4 females, 6 males)
- Placement of smartphone at a distance of ≈ 30 cm from their faces.
- Presence of natural ambient sounds generated by ceiling fans, outdoor noises
- 3 sessions
  - Expressions: Angry, Happy, Sad, Surprise
  - Each expression with variations for 1 minute
  - Ground truth
    - Manual Labeling
    - Automatic Vision-based labeling
    - Verification through close monitoring
- 6880 data samples

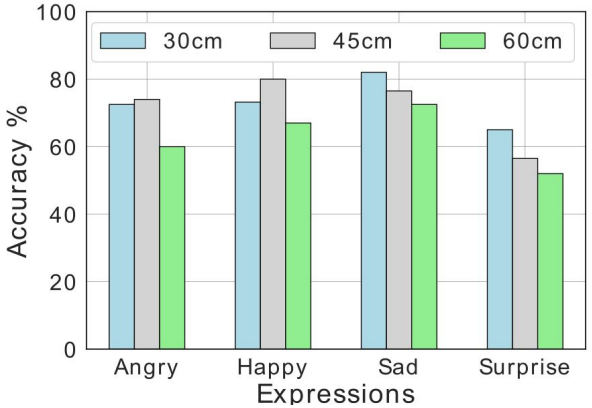
Results



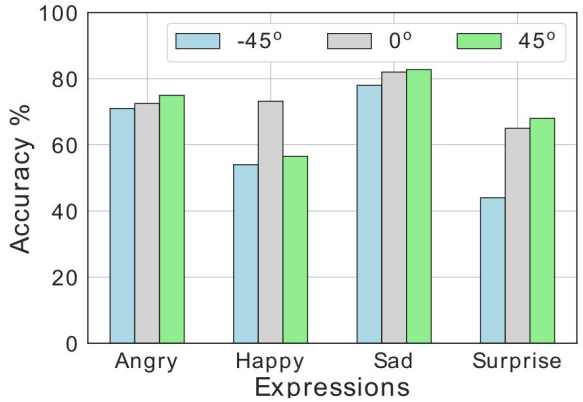
Overall classification accuracy of individual expressions

How do different environmental factors impact the performance of ExpresSense?

Results



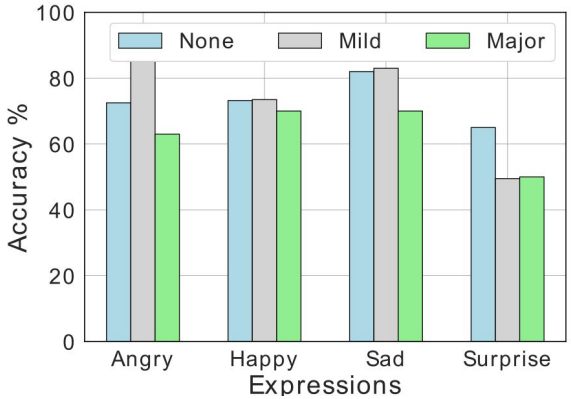
Distance



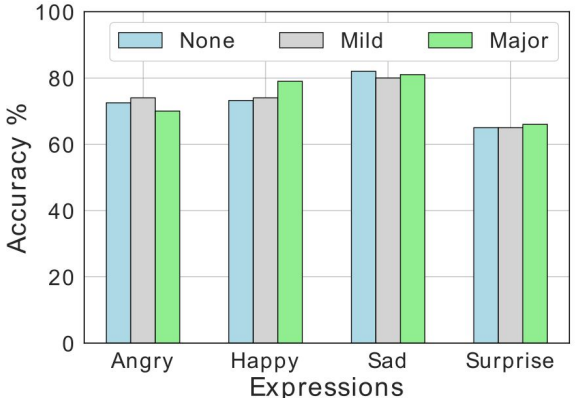
Elevation

Sensitivity Analysis of ExpresSense: Impact of Various Environmental Factors

Results



Motion

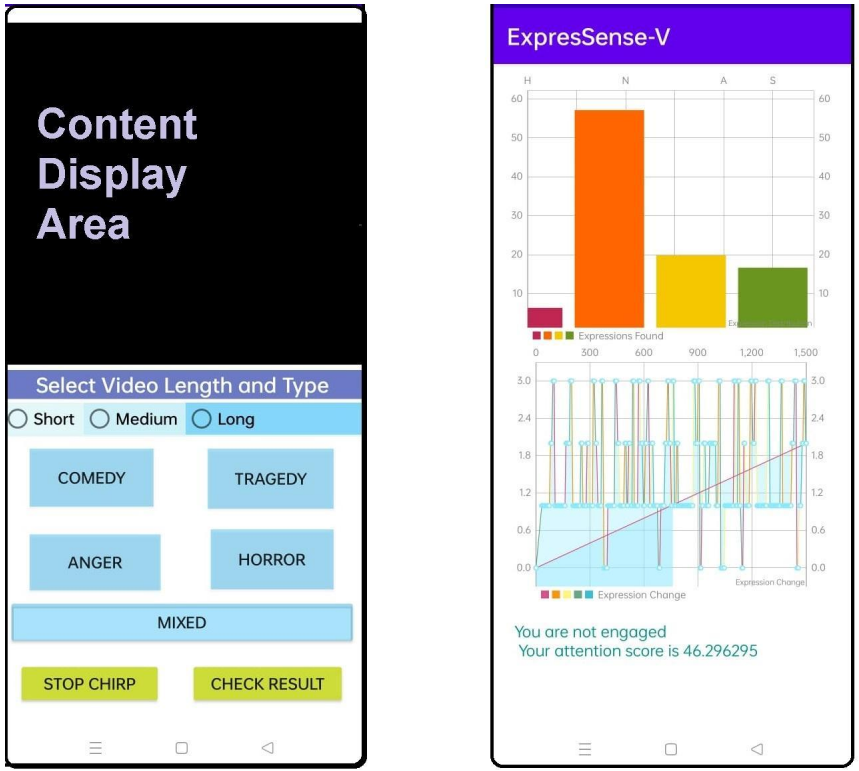


Finger Movement

Sensitivity Analysis of ExpresSense: Impact of Other Environmental Factors

How does ExpresSense perform under natural expressions?

ExpresSense Video Streaming Application

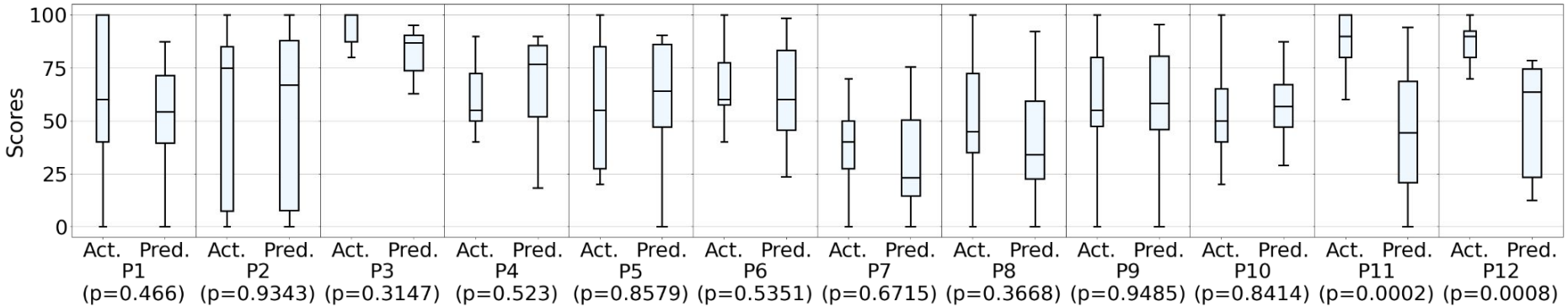


Interface of ExpresSense Video Streaming App: The Content View (left) and the Result View (right)

Experimental Setup

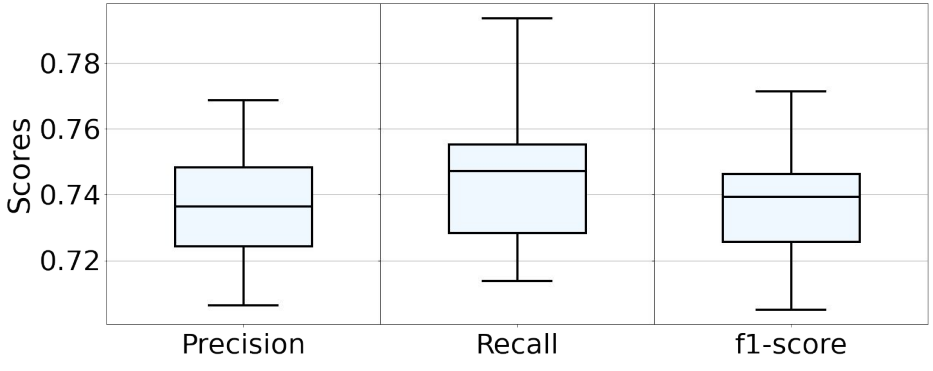
- **12 participants (5 females, 7 males)**
- **15 YouTube videos**
- **Genres: Comedy, Tragedy, Anger, Horror , Mixed**
- **Duration: Short videos (7 mins), medium videos (15 mins), long videos (30 mins)**
- **Ground Truth**
  - **85 Questions from the video content**
  - **Self-assessment**

Results

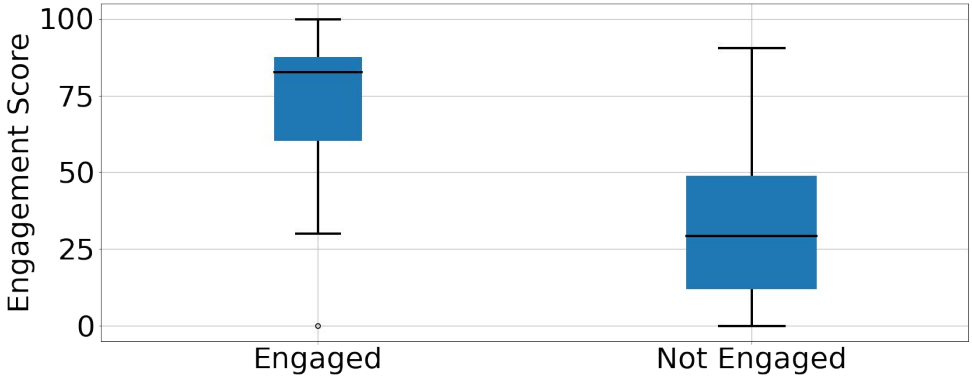


Distribution of participant-wise actual and predicted engagement scores in ExpresSense.

Results



Comparison of Overall Precision, Recall and f1-score for self reported engagement indicator vs predicted engagement indicator for ExpresSense

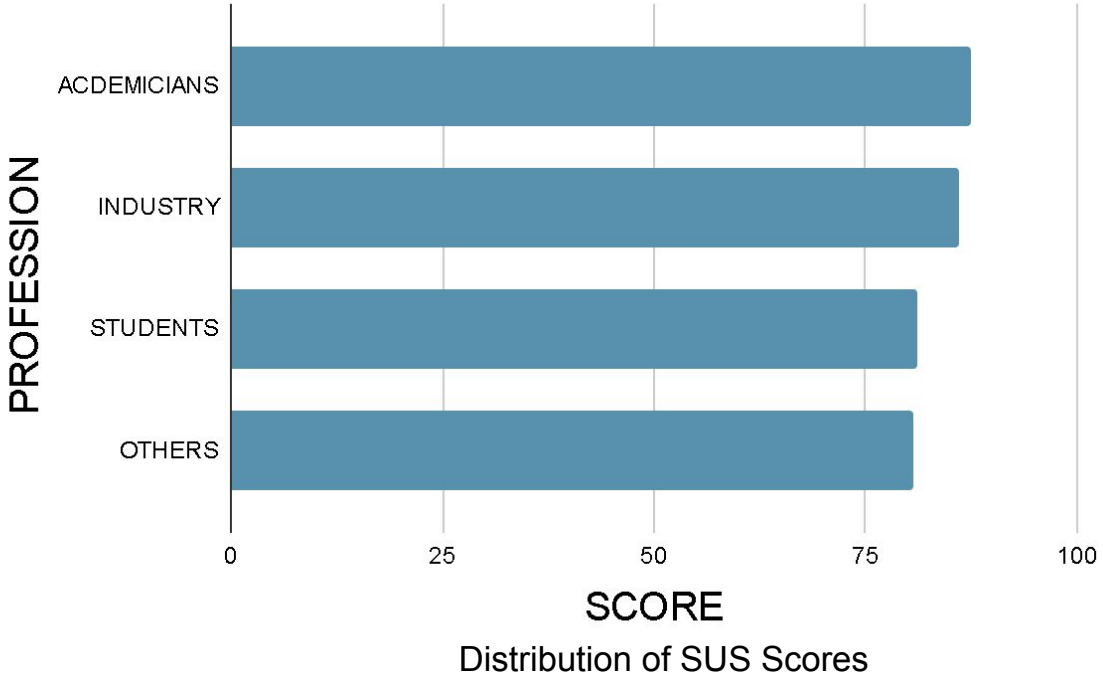


Correlation between engagement score and engagement indicator, as predicted by ExpresSense.

How usable ExpresSense is in practice?

Usability Study

- 72 participants
- System Usability Scale (SUS)
- SUS score of 85.34



Distribution of SUS Scores

Discussion

- Near-ultrasonic nature of the signals
- Effects of obstruction and movement
- Overall, the system shows significant performance and the scope of global acceptance.