Augmented Reality and Affective Computing for Nonverbal Interaction Support of the Visually Impaired

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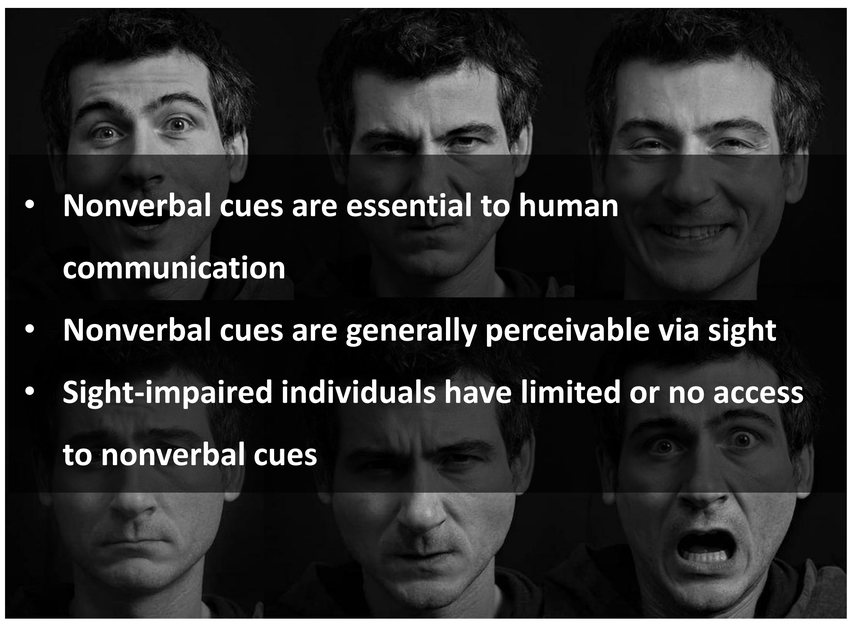
1. Introduction



- **Nonverbal cues are essential to human communication**
- **Nonverbal cues are generally perceivable via sight**
- **Sight-impaired individuals have limited or no access to nonverbal cues**

2. Background

Affective computing: aims at understanding and developing the technology for *detecting*, *interpreting*, *responding to* human affect

Affect

- moods and emotions
- observable through physiological signals (e.g., tone of voice, facial expressions, gestures)

Augmented Reality(AR)

- Most studies focus on sight
- AR also covers other sensory augmentation

Types of affective computing systems

- **SER**: Speech Emotion Recognition
  - Recurrent Neural Networks (RNN)
- **FER**: Face Expression Recognition
  - Convolutional Neural Networks (CNN)
- **GR**: Gesture Recognition
  - Markov Models / Finite State Machines

Important characteristics

- Performance, complexity, size

Related Work on Assistive AR

- Auditory and haptic substituting sight
- Navigation, obstacle avoidance, object detection [1]
- Enhancing sight; only for partially impaired

3. Proposed Solution

SOLUTION PROPOSITION

- Wearable technologies
- Augmented Reality
- Affective Computing

TECHNICAL CHALLENGES

- Processing images from a moving camera
- Battery / Compute Limitations

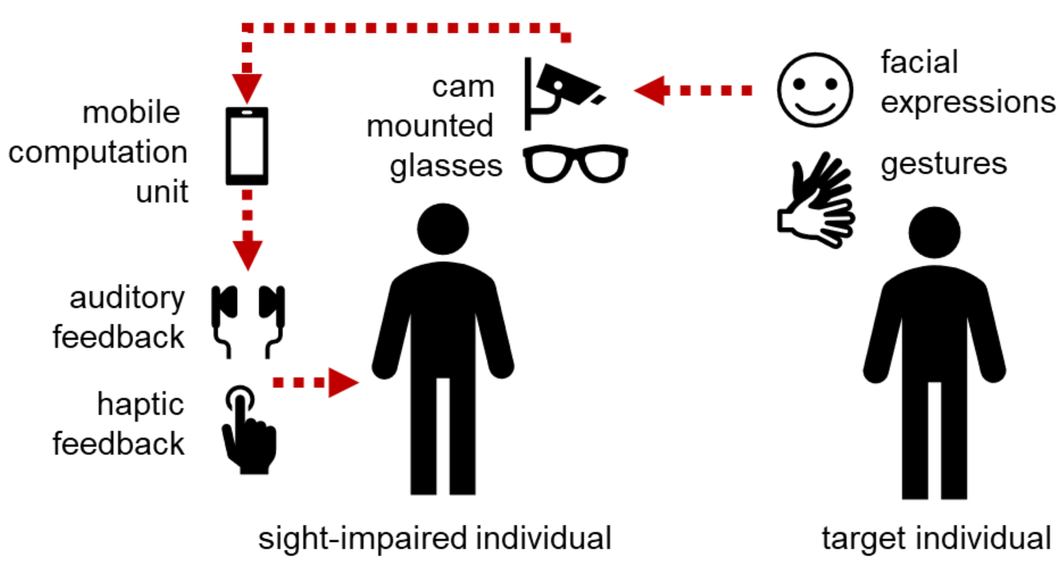
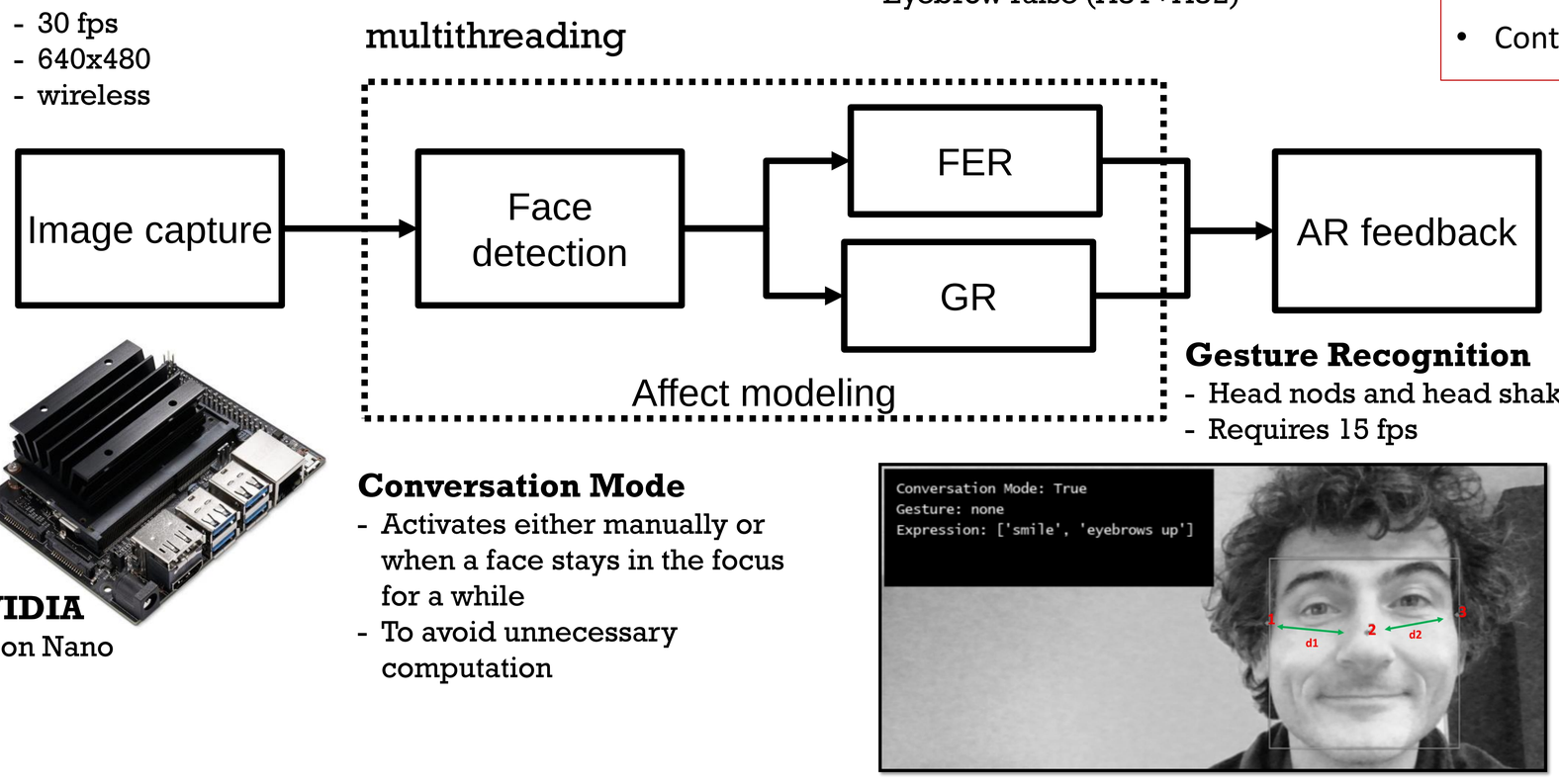


Figure 1. The conceptual schematics of the proposed solution

Aimcam Pro 2i
- 30 fps
- 640x480
- wireless

Facial Landmark Extraction
- Dlib
- (68x2) vectors

Facial Expression Recognition
- Based on AU detection
- Smile (AU6+AU12),
- Frown (AU4),
- Eyebrow raise (AU1+AU2)



NVIDIA
Jetson Nano

Conversation Mode
- Activates either manually or when a face stays in the focus for a while
- To avoid unnecessary computation

Gesture Recognition
- Head nods and head shakes
- Requires 15 fps

FER Model
- CNN
- 4 convolutional layers
- 32, 32, 64, 64 filters
- ReLU activation
- Trained on CK+ and DISFA
- Average testing accuracy F-1 = 77.12
- Model size: 13.5MB

AR: Haptic Feedback
- Custom built
- 24xTectonic vibration motors

Figure 2. The components of the prototype

4. Discussion

MOVING CAMERA

- Processing images from a moving camera
  - For FER; less problematic
  - For GR; requires special solution
  - Our design is robust against camera movements

RESOURCE LIMITATIONS

- Battery and compute Limits
- Avoid unnecessary computation
- Optimize performance/complexity of models

FEEDBACK TO THE USER

- What to convey?
- Avoiding information overload (e.g., aggregation, smoothing)
- How to convey?

WHY NOT EMOTIONS?

- Context dependent, cutural, and individual variances

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Team HART
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