

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

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

2. Background

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

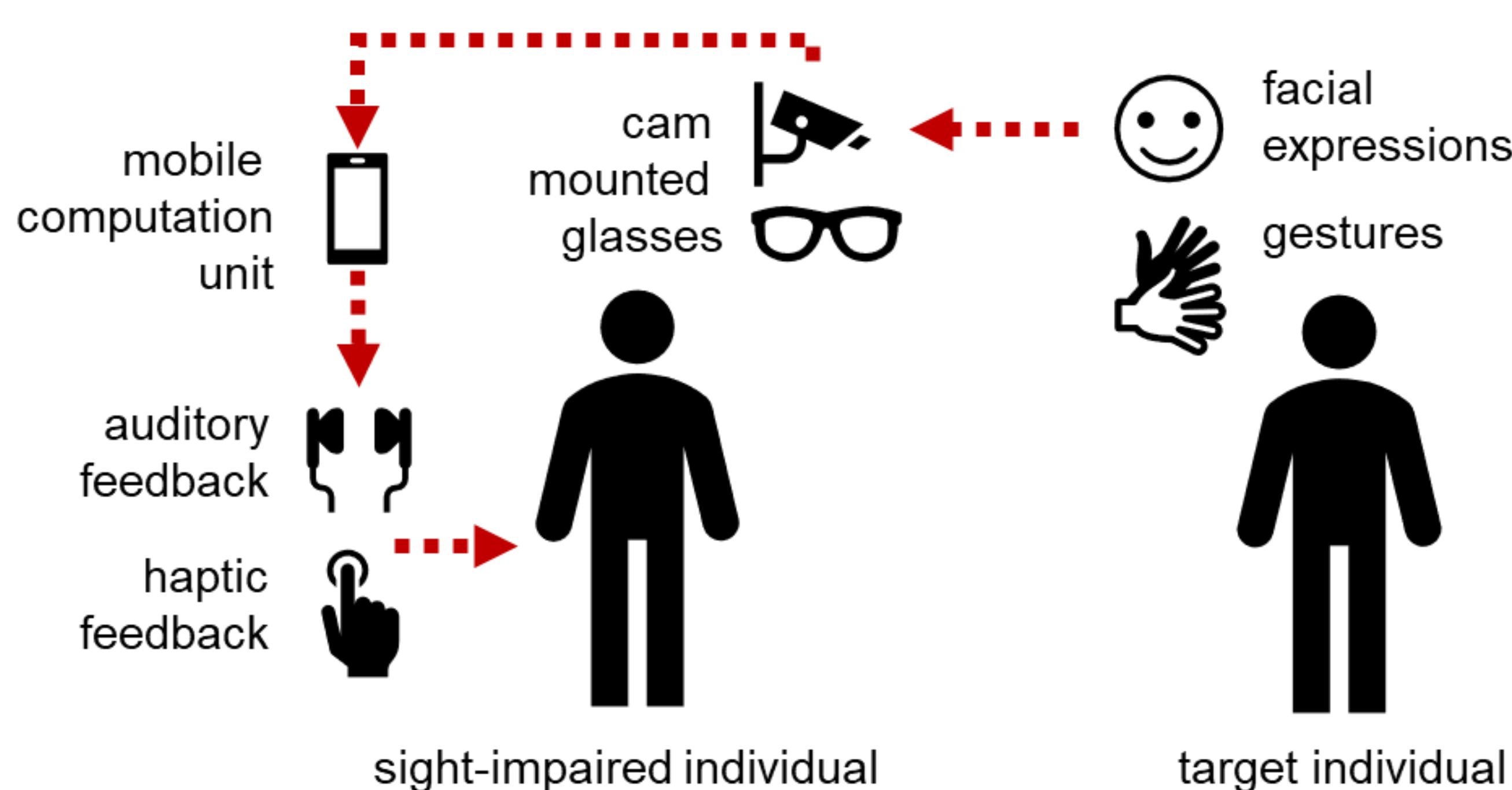


Figure 1. The conceptual schematics of the proposed solution

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, cultural, and individual variances



Aimcam Pro 2i

- 30 fps
- 640x480
- wireless

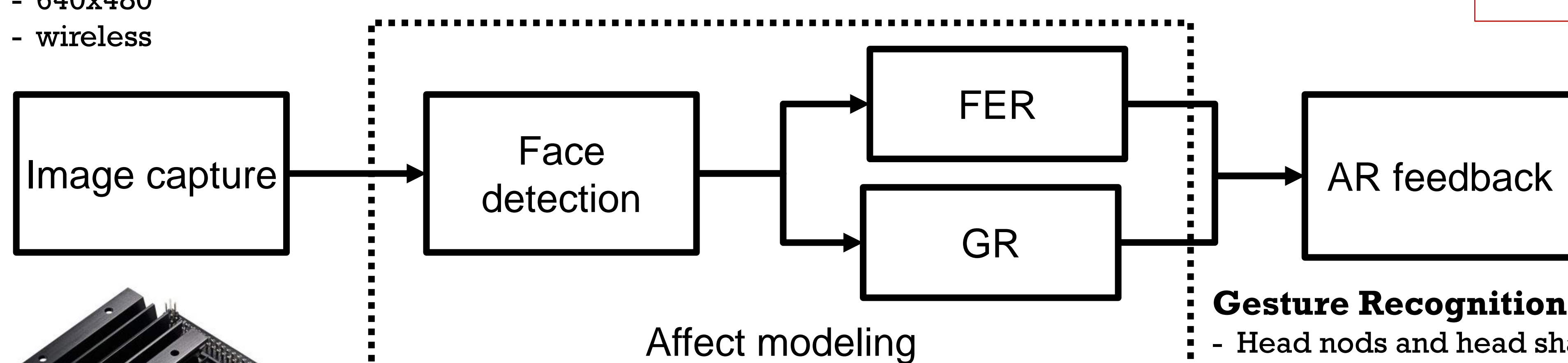
Facial Landmark Extraction

- Dlib
- (68x2) vectors

Facial Expression Recognition

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

multithreading



FER Model

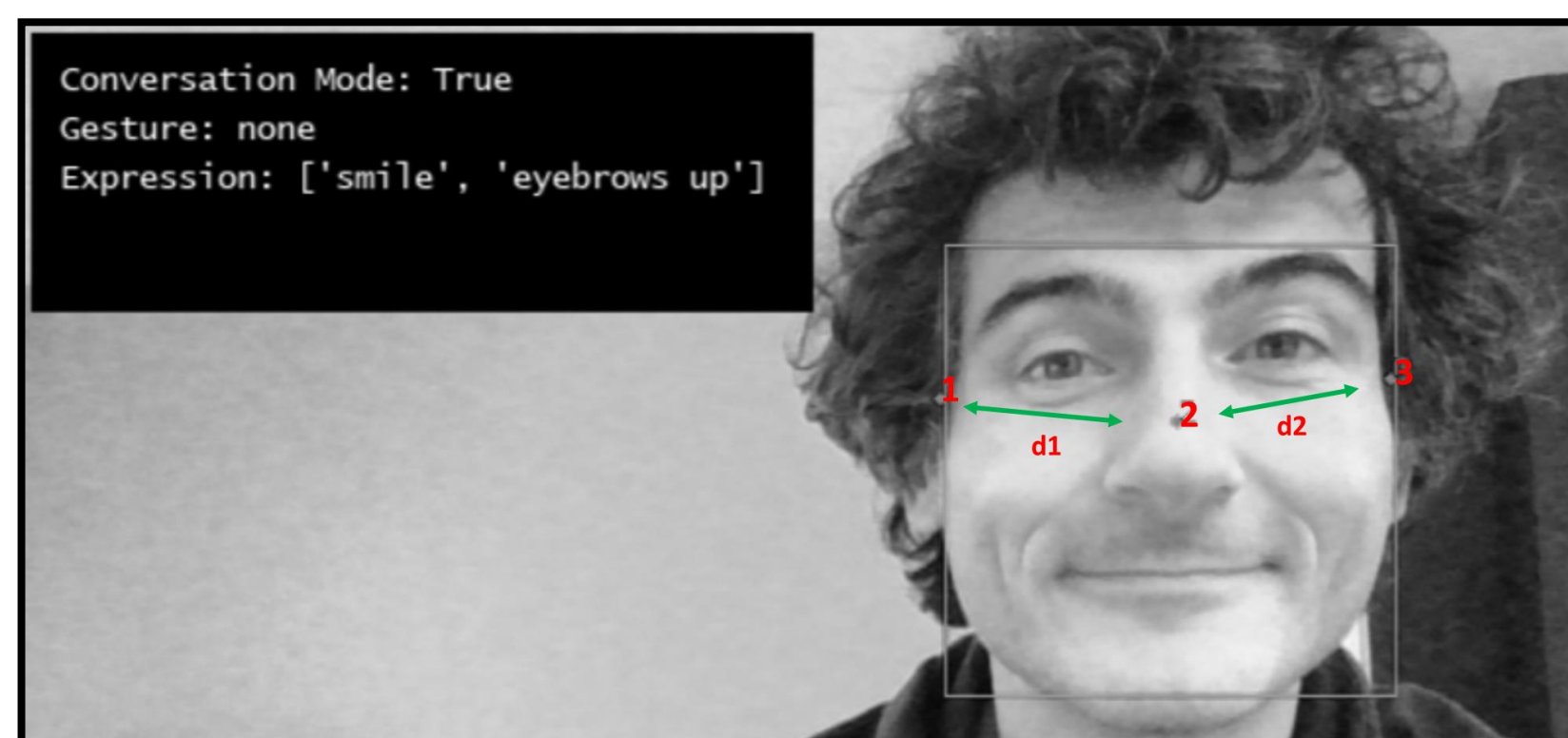
- CNN
- 4 convolutional layers
- 32, 32, 64, 64 filters
- ReLU activation
- Trained on CK+ and DISFA
- Average testing accuracy F-1 = 77.12
- Model size: 13.5MB

Gesture Recognition

- Head nods and head shakes
- Requires 15 fps

Conversation Mode

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



AR: Haptic Feedback

- Custom built
- 24xTectonic vibration motors

NVIDIA
Jetson Nano

Authors

Figure 2. The components of the prototype



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