IEEE VR 2023 SHANGHAI

ARACNI

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

25.03.2023

Deniz Iren, Krist Shingjergji, Felix Bottger, Corrie Urlings, Jelle Osinga, Sjoerd van de Goor, Damian Bukowski, Juliette Pasariello-Jansen, Roland Klemke

Center for Actionable Research of Open University (CAROU)

Open University of the Netherlands & Eindhoven University of Technology

CAROU ARACNI HART

CAROU ARACNI

HART

IEEE VR 2023
SHANGHAI

ARACNI

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

Deniz Iren
Center for Actionable Research of Open University (CAROU)

Presenter

Deniz Iren, PhD, PMP

Assistant Professor

Open University of the Netherlands (OU)

Department of Information Science

Center for Actionable Research of the OU (CAROU)

Contact:

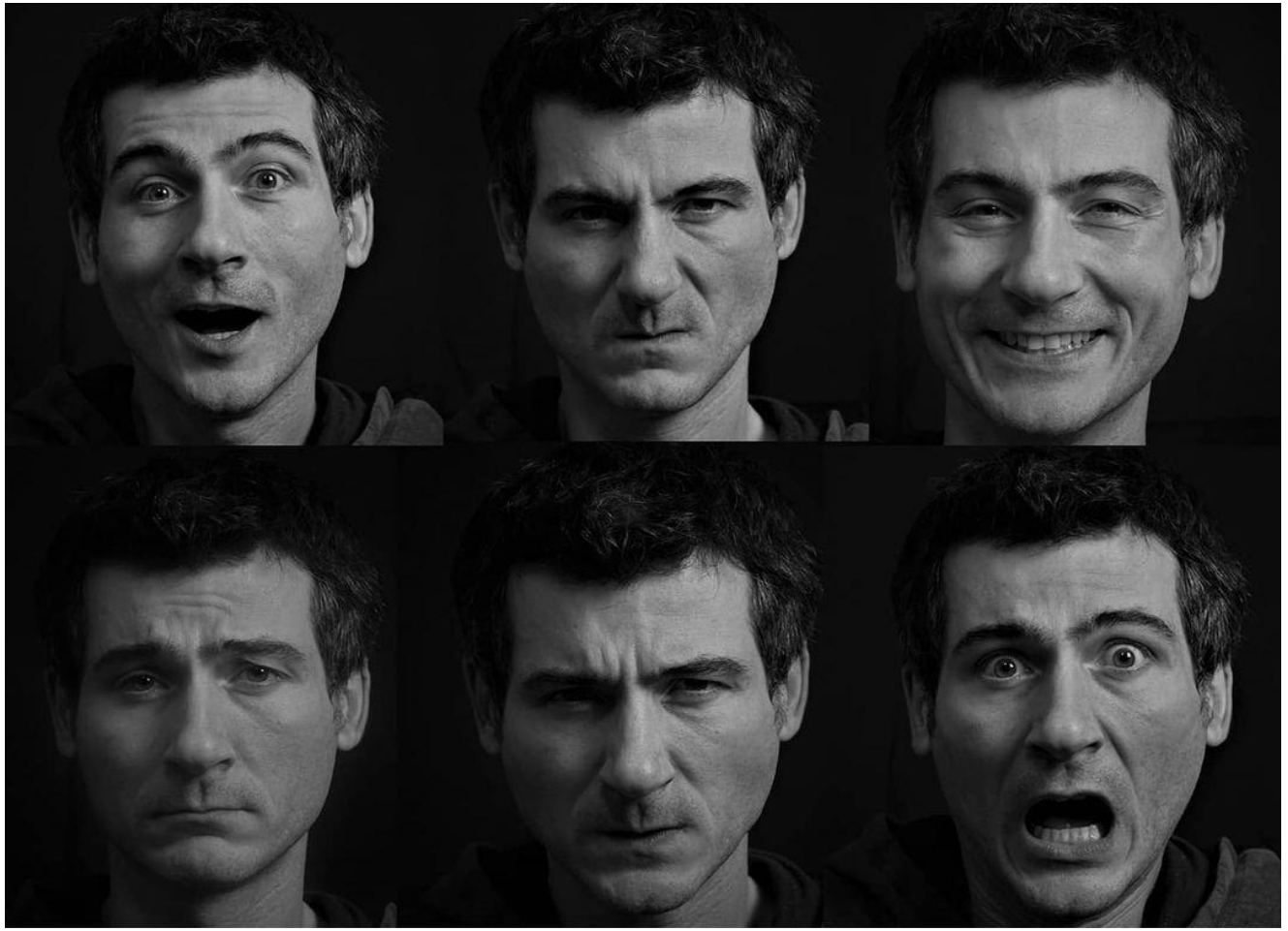
deniz.iren@ou.nl

https://www.linkedin.com/in/deniziren

Introduction

CONTEXT

- 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



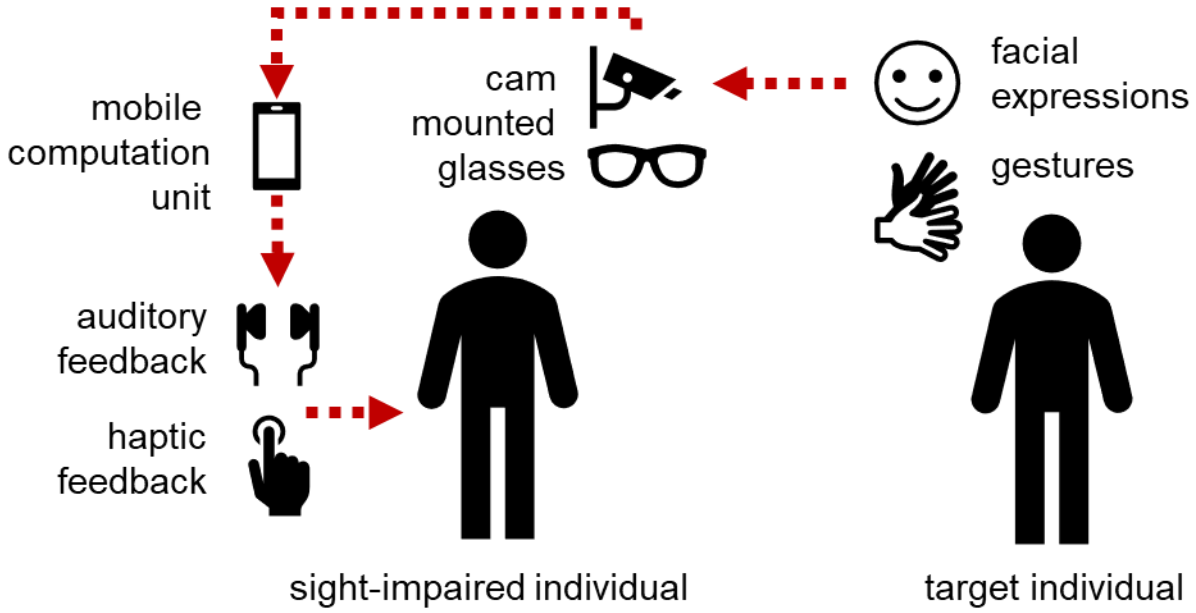
Proposed Solution

SOLUTION PROPOSITION

- Wearable technologies
- Augmented Reality
- Affective Computing

TECHNICAL PROBLEMS

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



Background: Affective Computing

- **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)

Technologies

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

Important characteristics

- performance
- complexity
- size

Background: Augmented Reality

AUGMENTED REALITY (AR)

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

ASSISTIVE AR TECHNOLOGY

- Auditory and haptic substituting sight
- Navigation, obstacle avoidance, object detection (Zahn & Kahn, 2022)
- Enhancing sight
  - only for partially sight-impaired

RELATED WORK

- Haptic belt conveys inferred emotions (Buimer et al., 2018)
- Similar pipeline using cloud or high-capacity computers

Difference

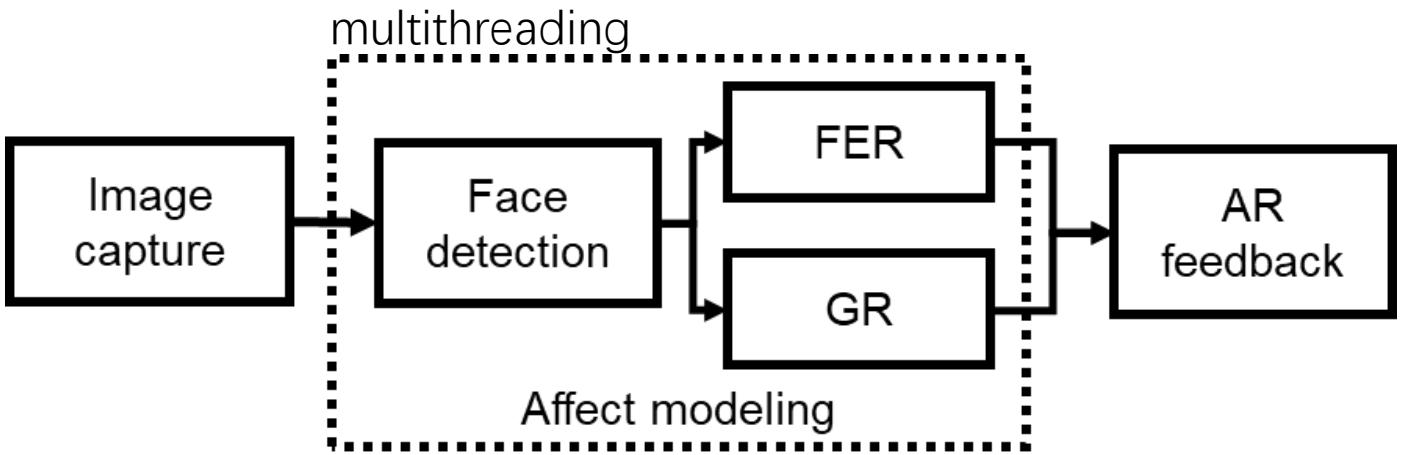
- Convey gestures and facial expressions instead of inferred emotions
- GR that is robust to camera movement
- Lightweight FER to overcome resource limitations

Prototype Design

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

NVIDIA Jetson Nano

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



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

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

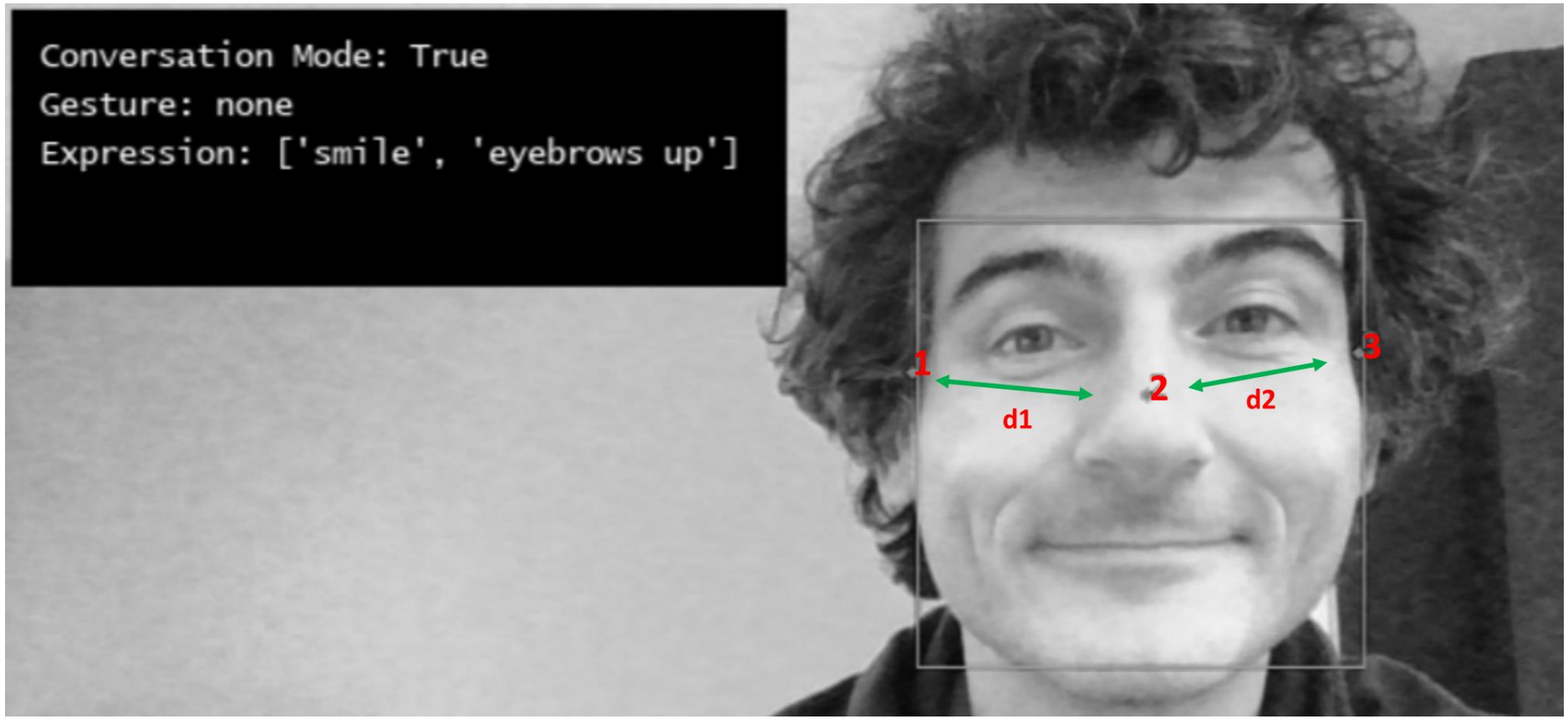
Facial Landmark Extraction
- Dlib
- (68x2) vectors

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

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

https://www.aimcam.com/products/aimcam-pro-2i

Gesture Recognition



Haptic Feedback

Discussion

MOVING CAMERA

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

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

FUTURE WORK

- User studies
- Haptic feedback patterns
- Thorough evaluation of the system

IEEE VR 2023
SHANGHAI

Thank you