
Secure and Usable Authentication Using Avatar Expression Blendshapes in Virtual Reality

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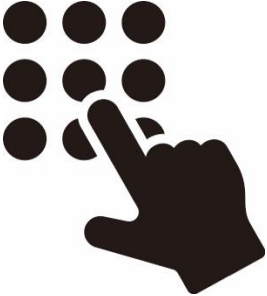




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Authentication in VR

Various authentication methods have been proposed.
But these studies have some challenges.

Example			
	PIN Code	Body Motion	Iris
Challenge	Usability	Observation Resistance	Sensor Device Cost



Authentication Using Facial Expression

Facial-expression-based authentication for VR has been proposed.

- Use the smile expression
- High observation resistance and temporal robustness

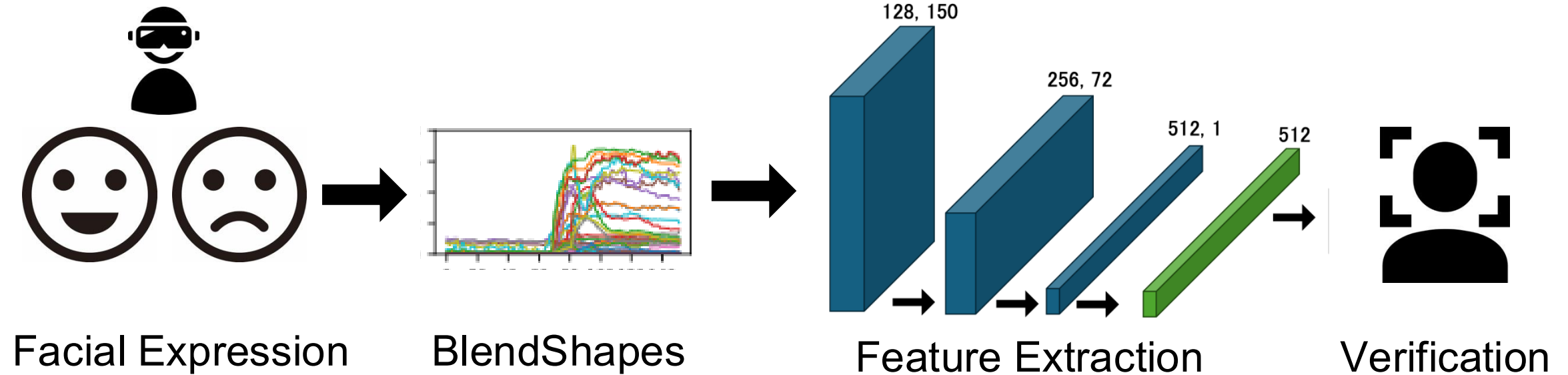


The following evaluations have not been performed.

- Performance evaluation expect for the smile expression
- Usability evaluation has not been conducted



Authentication Process





Authentication Model

Input

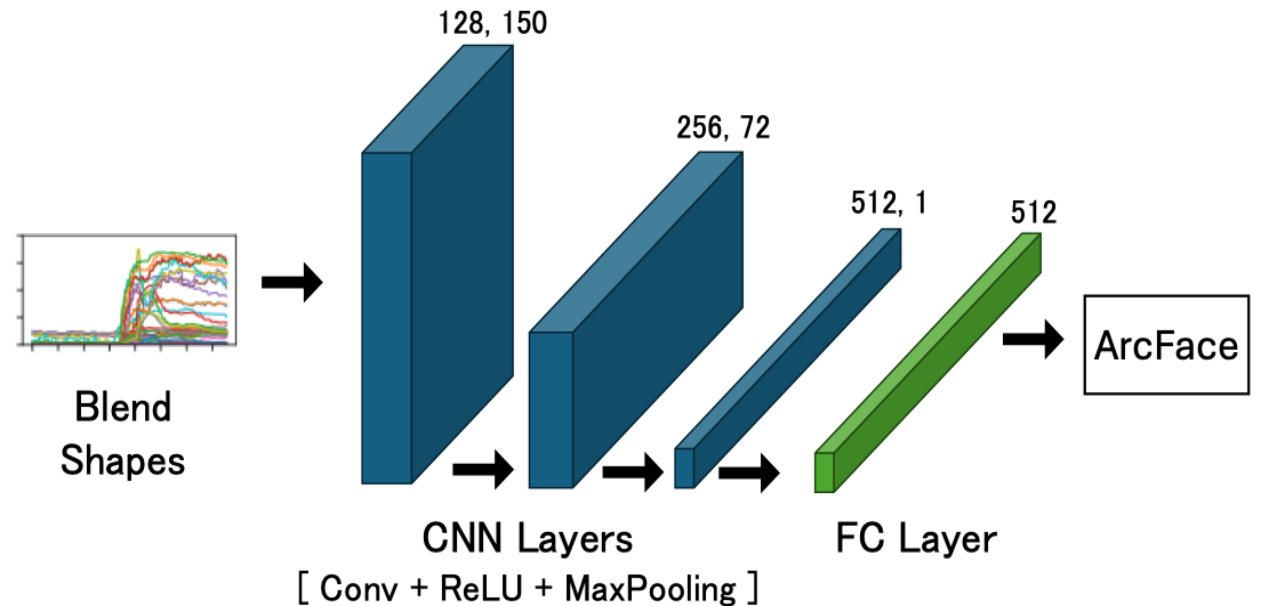
- BlendShape parameters extracted from facial expressions

Model

- 1D-CNN
 - 3 convolutional layers
 - A Fully connected layer
- ArcFace

Output

- Cosine similarity score





Evaluation

The authentication model is evaluated using 6 facial expressions.

- Angry, Disgust, Fear, Happiness (Smile), Sadness, Surprise

Dataset

- 20(samples) × 6(facial expressions) × 20(participants)
- Each sample consists of 63 facial expression BlendShapes recorded for 5 seconds

Scenario

- Training an authentication model for each facial expression
- Evaluation using 5-fold cross-validation
 - 16 participants are used for training, 4 participants are used for testing



Evaluation Metrics

The authentication model is evaluated from two perspectives

Recognition Performance

- Area Under Curve (AUC)
- Equal Error Rate (EER)

Usability

- System Usability Scale (SUS)
- NASA Task Load Index (NASA-TLX)



Result | Recognition Performance

Happiness is the best facial expression for performance.

EER

- The lowest EER : Happiness, 0.00167
- The highest EER: Surprise, 0.175

AUC:

- The lowest AUC : Surprise, 0.891
- The highest AUC: Happiness, 0.999

Expression	EER ↓	AUC ↑
Angry	0.0667	0.950
Disgust	0.0417	0.978
Fear	0.0917	0.967
Happiness	0.0167	0.999
Sadness	0.105	0.952
Surprise	0.175	0.891



Result | Usability

Happiness is the best facial expression for usability.

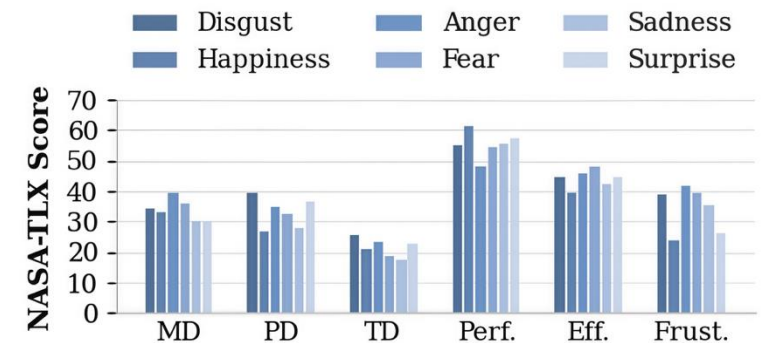
SUS Score

- Happiness and Surprise achieved over 68 (Good Usability)

Expression	SUS Score
Angry	64.38
Disgust	61.62
Fear	66.50
Happiness	71.75
Sadness	67.88
Surprise	71.12

NASA-TLX Score

- Happiness achieved the lowest score in Mental Demand (MD) and Physical Demand (PD)
- Disgust and Angry achieved over 40 score in Effort (Eff.) and Frustration (Frust.)





Limitation and Future Work

Limitation

- The height of the displayed UI was not stable during data collection
- 8 BlendShapes related to eye gaze direction may have acted as noise in the verification

Future Works

- It is necessary to investigate continuous identity authentication methods that consider temporal consistency