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ACHI 2020, The 13th International Conference on Advances in Computer-Human Interactions

Facial Mimicry Training Based on 3D Morphable Face Models

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ACHI 2020 | November 2020

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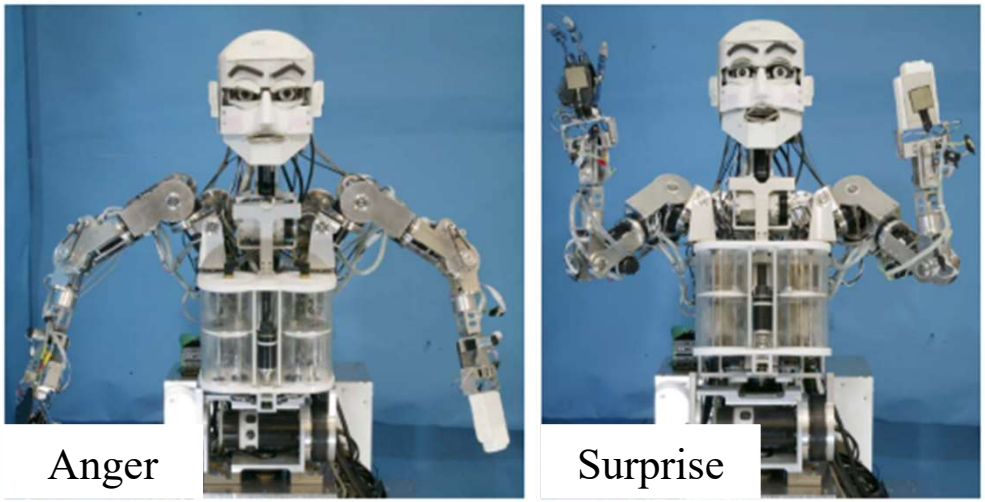
Background :: Facial Mimicry

Facial mimicry is an important non-verbal communication that can promotes favorable social behavior and positive relationships.

Automated facial expression recognition has been used in the development of humanoid robots to enable them to mimic human-like emotions [1].



Emotional Expressions of WE-4R with RTR-2 [1]

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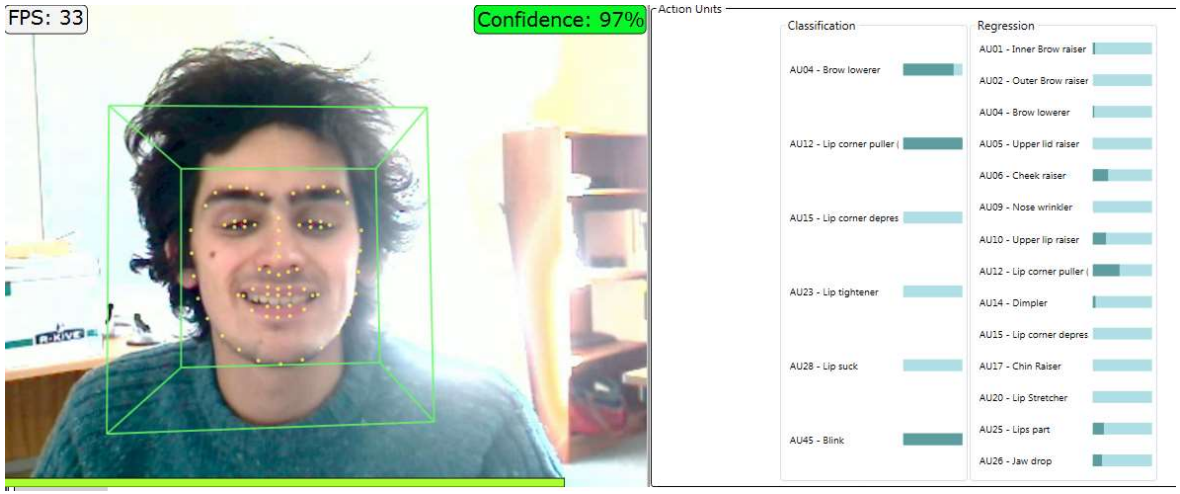
Background :: Facial Mimicry

Recent computer vision technologies (i.e. OpenFace [2]) have made it possible to perform conventional face recognition processes such as face detection, face matching, facial feature extraction, and expression classification in real time.

However, surprisingly few attempts have been made to measure the similarity of facial expressions.



OpenFace [2]

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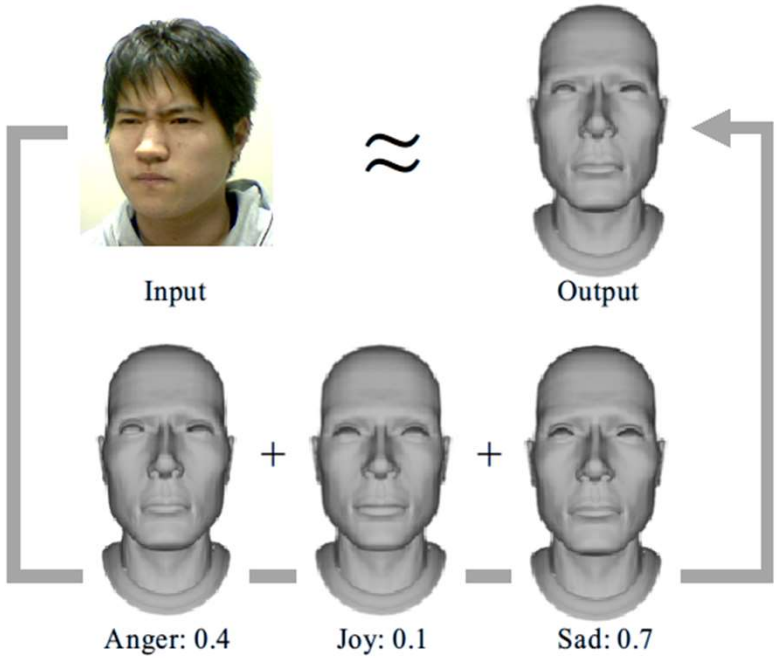
Background :: Facial Mimicry

Recently, 3D morphable models (3DMM) [3] have been widely used to create virtual faces in some software application programs, such as Augmented Reality (AR) and messaging apps.

The advanced computer vision techniques have enabled to fit the model to the corresponding facial image.



Expression of a certain emotion through the synthesis of multiple emotions (3DMM).

Research Aims

This study proposes a self-learning-based facial mimicry training system based on 3DMM to measure how close a person can mimic another person's facial expressions.

The proposed system uses blended emotive expressions of the models to find the most similar shape that matches a given facial image.

Expression	Intensity			
	0.25	0.5	0.75	1.0
Joy				
Surprise				

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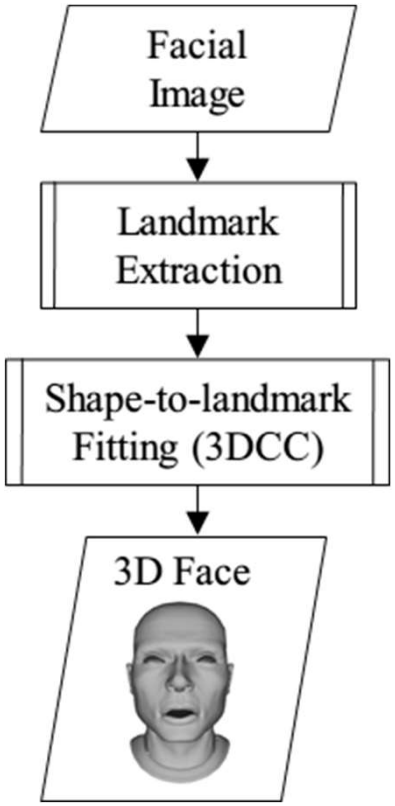
Facial Mimicry Training

Our attempt to analyze the facial mimicry of a pair of facial images takes three steps.

STEP 1: Generation of 3D Face Data

STEP 2: Point Cloud Extraction

STEP 3: Similarity Analysis



STEP 1

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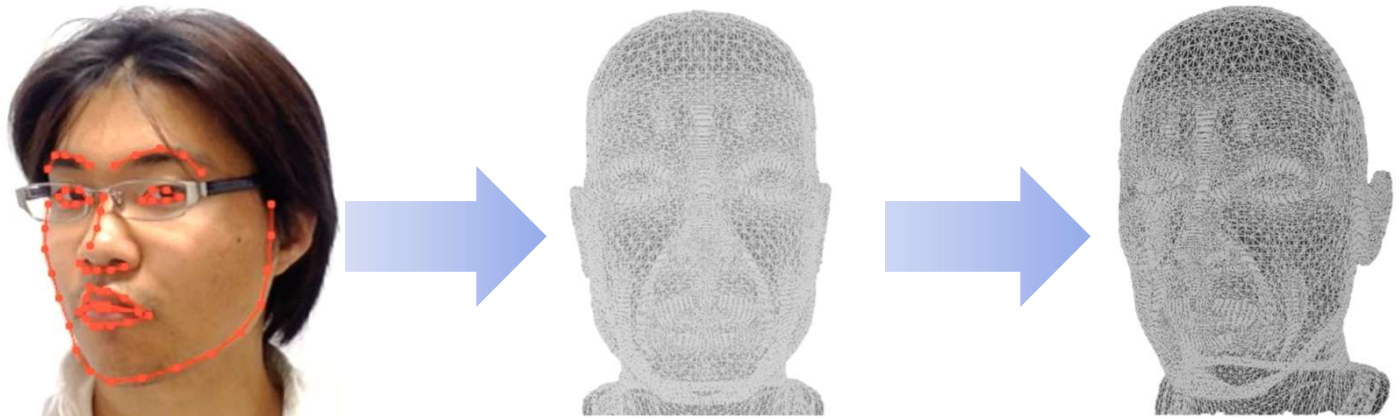
STEP 2: Point Cloud Extraction

68 facial landmark points were extracted from the face image using the Dlib library [4]. The 3D face data was then fitted to these landmark points by solving the Perspective-n-Point (PnP) problem to generate 3D face data that represents the original face image.



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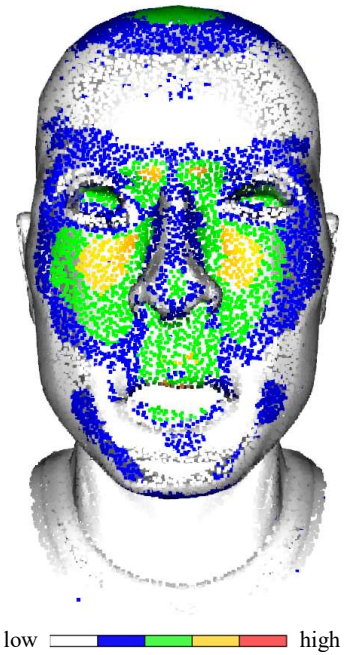
Facial Mimicry Training

STEP 3: Similarity Analysis

To analyze the similarity between facial images, the distance of each point on the original face was calculated to determine the distance to the target face.

The score for the mimicry is calculated as the correlation coefficient between the 3D points of the generated 3DMM for the subject and the target.



Differences in distance between the point clouds of 3DMM for the target face and the mimetic .

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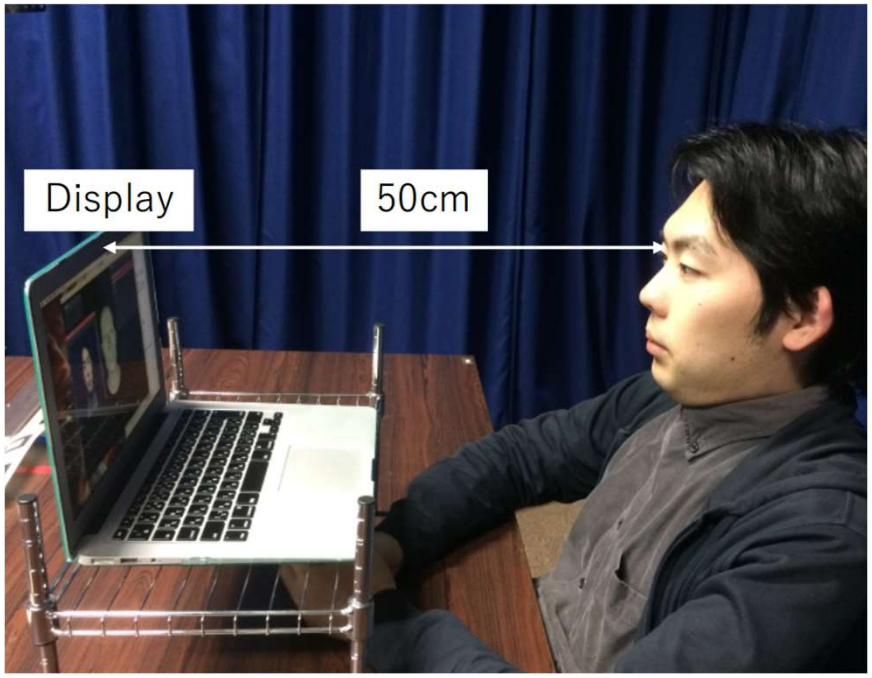
Experiments & Results

Three male subjects (mean age 21.7 years) were recruited for the experiments. The room was set up with a table and stool for the subjects. On the table was a laptop computer that was used to display the target face to be mimicked by the subject. The monitor resolution was set at 1,440 × 900 and the refresh rate was 60 Hz. The subject was seated at approximately 50 cm from the laptop.



The experiment setup in this study.

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Experiments & Results

Subjects completed one practice block followed by six experimental blocks. For every block, a target face to mimic was displayed on the laptop. Subjects were asked to press the space button on the keyboard when they best imitate the target's face image.

Acts	Target Faces	Mimicry		
		Subject I	Subject II	Subject III
A				
B				
C				
D				
E				

The target face and facial mimicry performed by each subject.

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Experiments & Results

Tables I to III show the correlation coefficients of the mimicry results for the target faces by the three subjects. There is a high correlation between the 3DMM of the target face and the subject's face that imitated the target face (values shown in the gray background). Here, the correlation coefficient between the 3DMM of the target face and the 3DMM of the subject's face that mimicked that face was greater than 0.98. When the subjects imitated different faces, the correlation coefficient was less than 0.94.

TABLE I. CORRELATION COEFFICIENTS OF THE RESULTED MIMICS BY THE SUBJECT I AGAINST THE TARGET FACES.

		Target Faces				
		A	B	C	D	E
Mimicries	A	0.994	0.908	0.894	0.913	0.873
	B	0.913	0.991	0.907	0.925	0.899
	C	0.881	0.891	0.987	0.926	0.923
	D	0.905	0.917	0.931	0.993	0.929
	E	0.87	0.891	0.923	0.924	0.997

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Experiments & Results

TABLE II. CORRELATION COEFFICIENTS OF THE RESULTED MIMICS BY THE SUBJECT II AGAINST THE TARGET FACES.

		Target Faces				
		A	B	C	D	E
Mimicries	A	0.988	0.908	0.892	0.906	0.867
	B	0.913	0.994	0.906	0.923	0.896
	C	0.88	0.888	0.985	0.926	0.927
	D	0.894	0.91	0.924	0.989	0.925
	E	0.847	0.872	0.908	0.906	0.985

TABLE III. CORRELATION COEFFICIENTS OF THE RESULTED MIMICS BY THE SUBJECT III AGAINST THE TARGET FACES.

		Target Faces				
		A	B	C	D	E
Mimicries	A	0.997	0.912	0.899	0.915	0.877
	B	0.919	0.995	0.911	0.928	0.901
	C	0.895	0.903	0.998	0.935	0.93
	D	0.912	0.924	0.934	0.997	0.929
	E	0.866	0.888	0.921	0.921	0.996

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Conclusion

In this study, we have demonstrated that our self-learning-based facial mimicry training system is able to measure how close a person can mimic another person's facial expressions.

By using this tool, users can train themselves to closely mimic someone's face interactively by referring to the expression intensity of each 3DMM constructing the blended 3DMM.

In our further study, we will confirm the performance of the training system using a fine 3DMM that is generated from a large three-dimensional face dataset.

References

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4. V. Kazemi and J. Sullivan, “One millisecond face alignment with an ensemble of regression trees,” Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2014), pp. 1867–1874, 2014.