



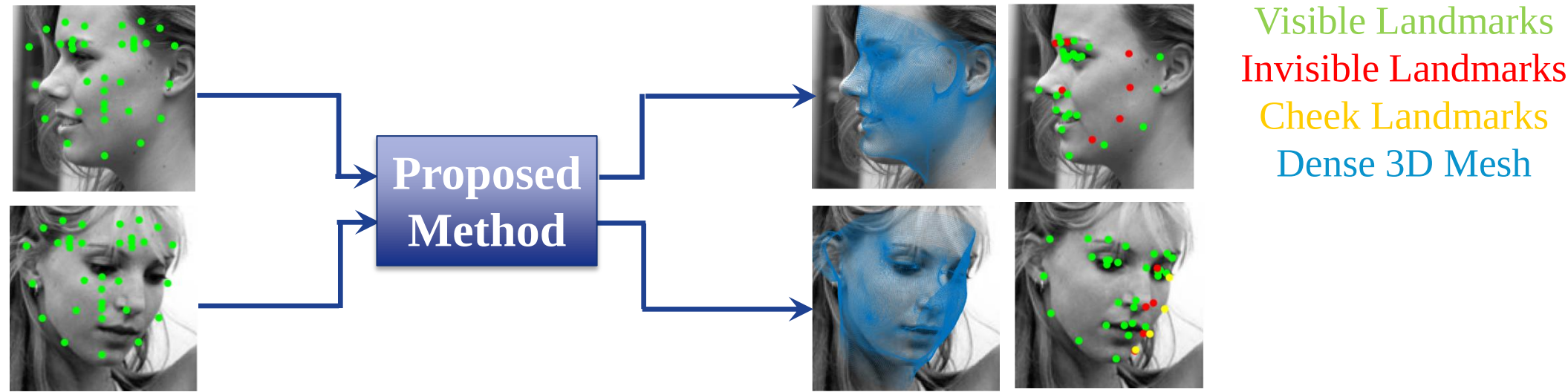
Large-Pose Face Alignment via CNN-Based Dense 3D Model Fitting

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Introduction



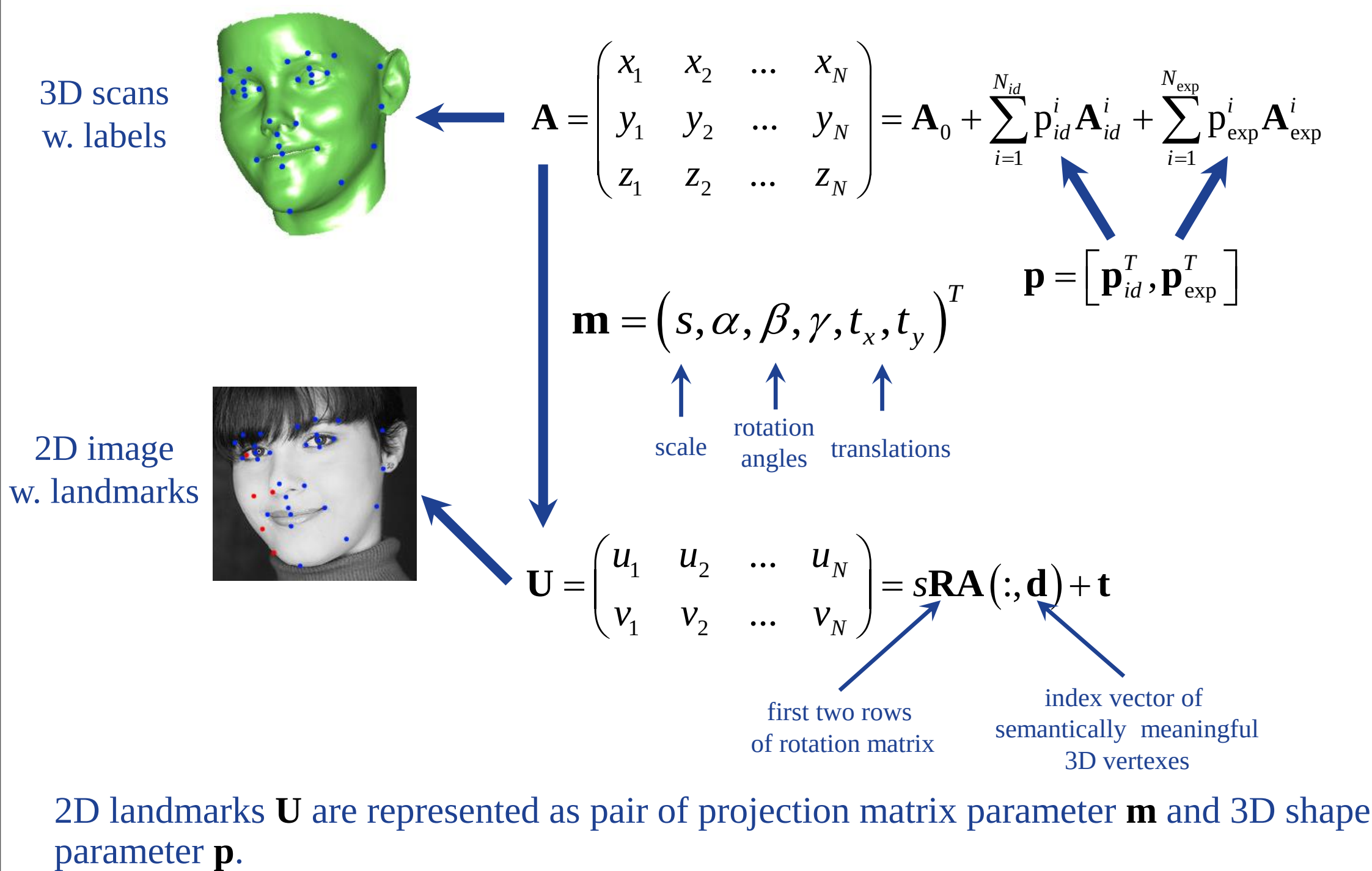
The main contributions of proposed method:

- Large-pose face alignment by fitting a dense 3DMM.
- Cascaded CNN-based 3D face model fitting with integrated landmark marching.
- Dense 3D face-enabled pose-invariant local features.

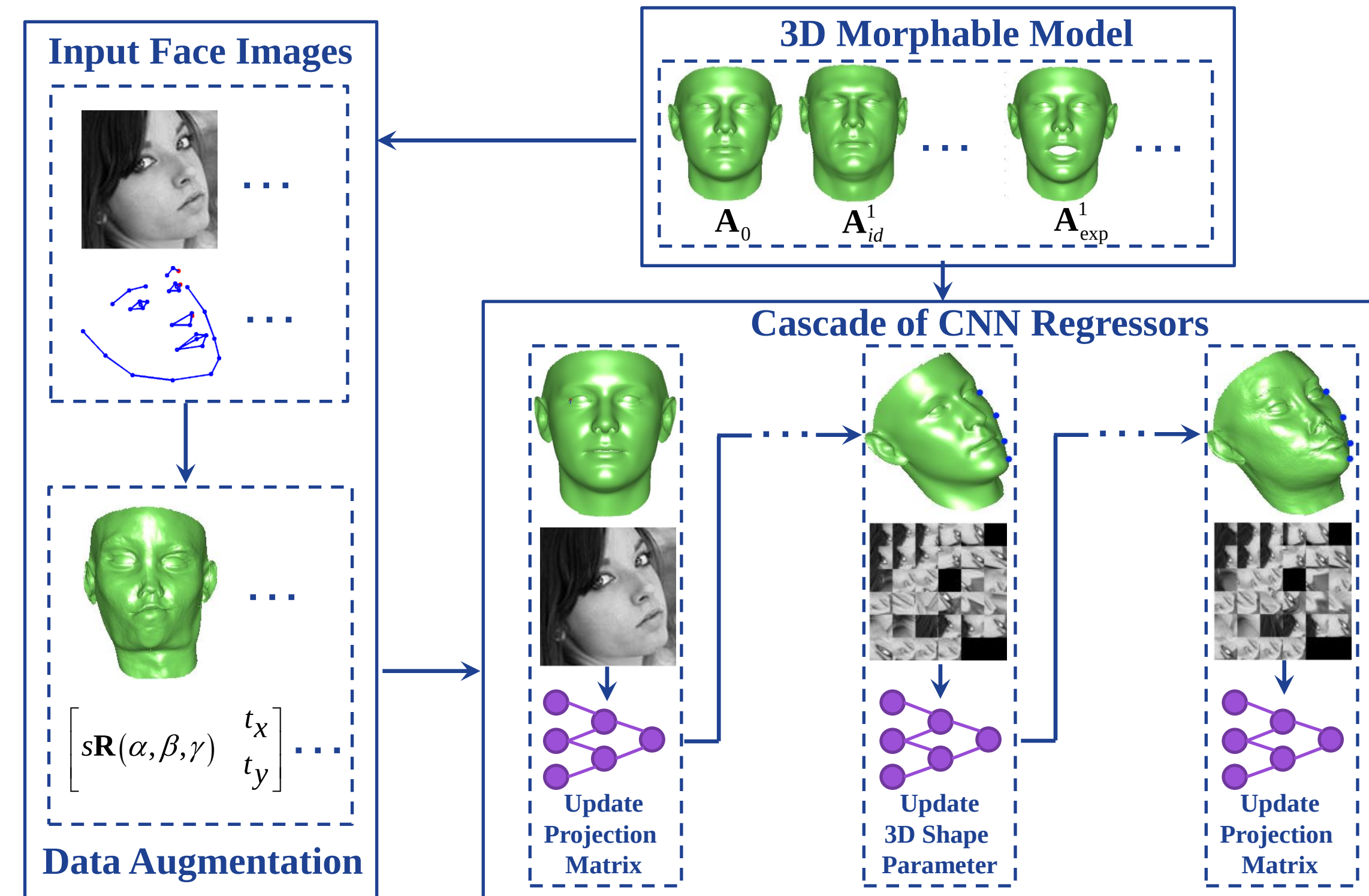
Prior Work

Method	Dense 3D model fitting	Visibility	Pose-related database	Pose range	Landmark #	Estimation Error
RCPR (ICCV2013)	NO	Yes	COFW	frontal w. occlu	19	8.5
TSPM (CVPR2012)	NO	NO	AFW	all poses	6	11.1
CDM (ICCV2013)	NO	NO	AFW	all poses	6	9.1
TCDCN (ECCV2014)	NO	NO	AFLW, AFW	$< \pm 60^\circ$	5	8.0, 8.2
PIFA (ICCV2015)	NO	Yes	AFLW, AFW	all poses	21, 6	6.5, 8.6
Proposed method	Yes	Yes	AFLW, AFW	all poses	34, 6	4.7, 7.4

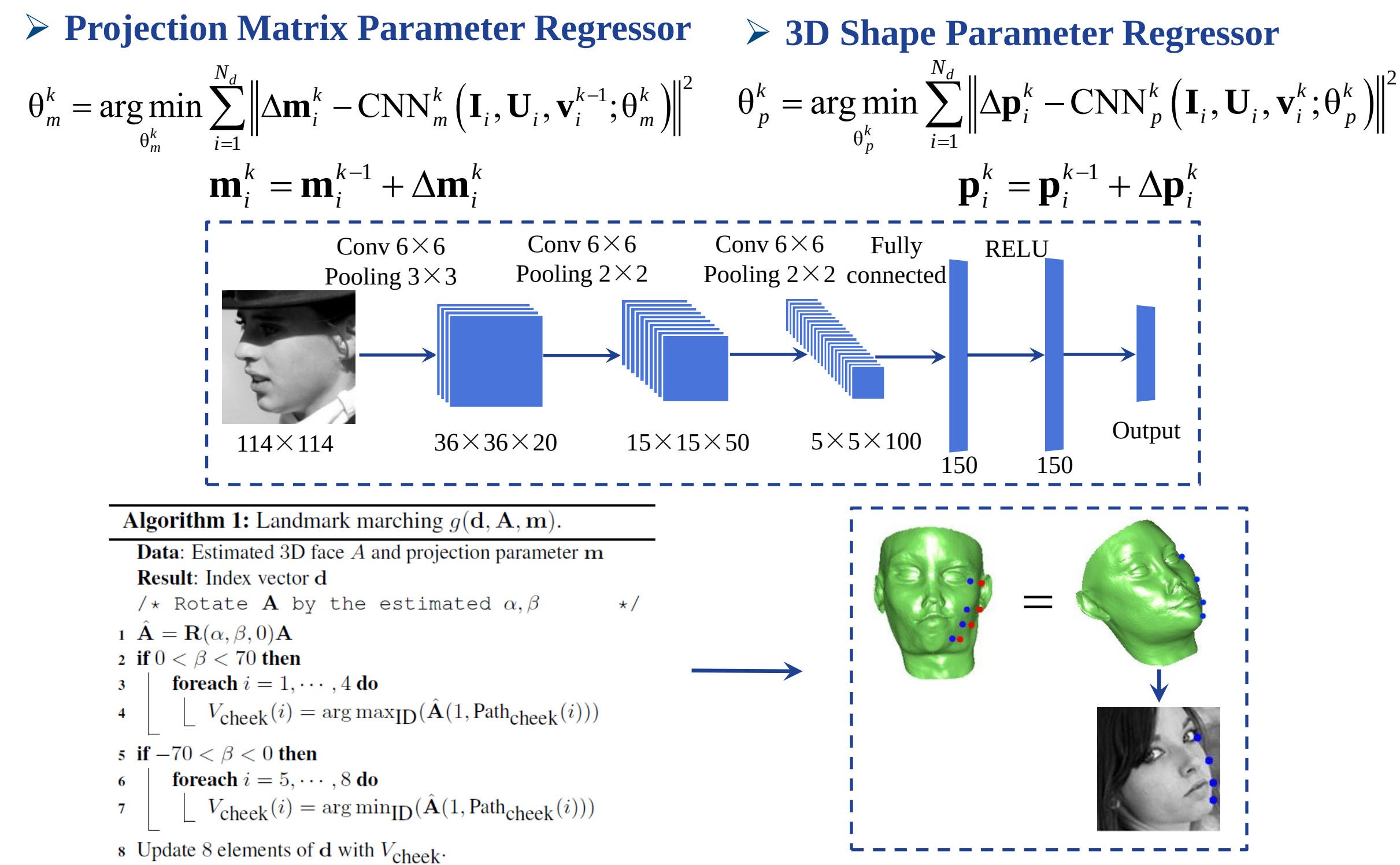
3D Face Modeling



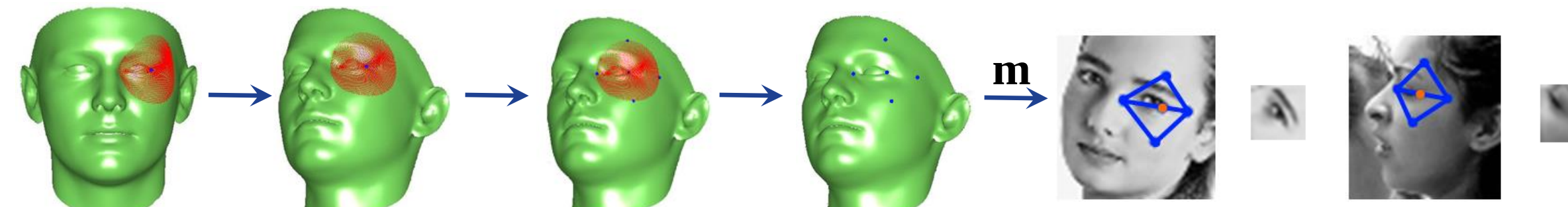
Proposed Method



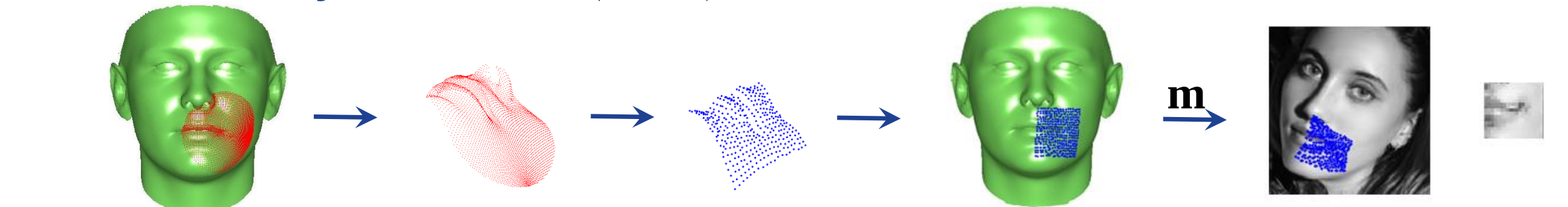
Cascaded Couple-Regressor



Piecewise Affine-Warped Feature (PAWF)

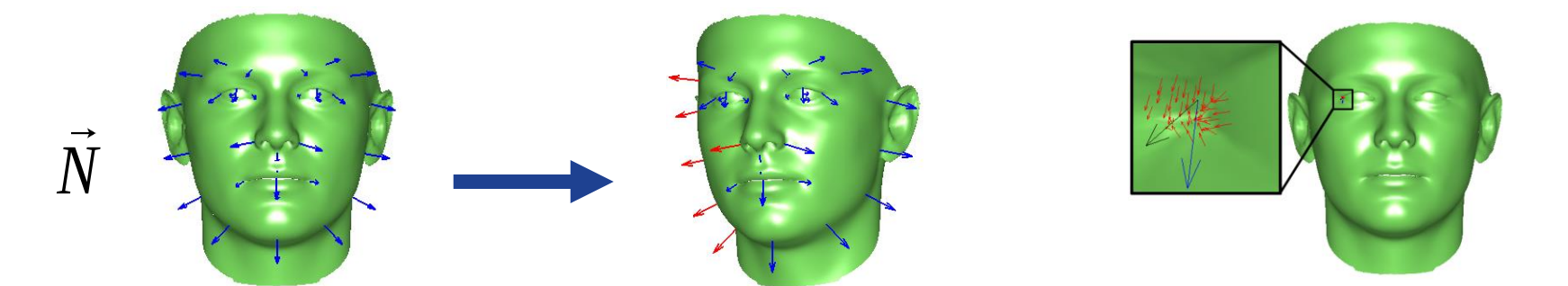


Direct 3D Projected Feature (D3PF)



3D Surface-Enable Visibility

- We use the average of normal around a 3D landmark as the person-specific 3D surface normal.

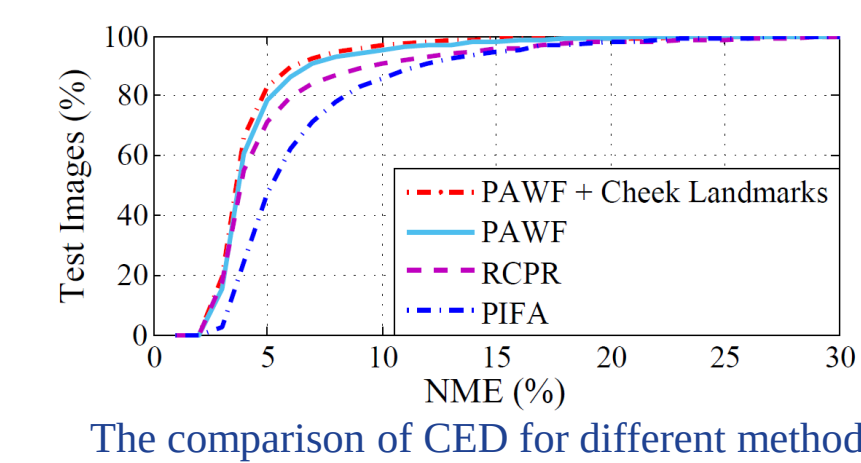
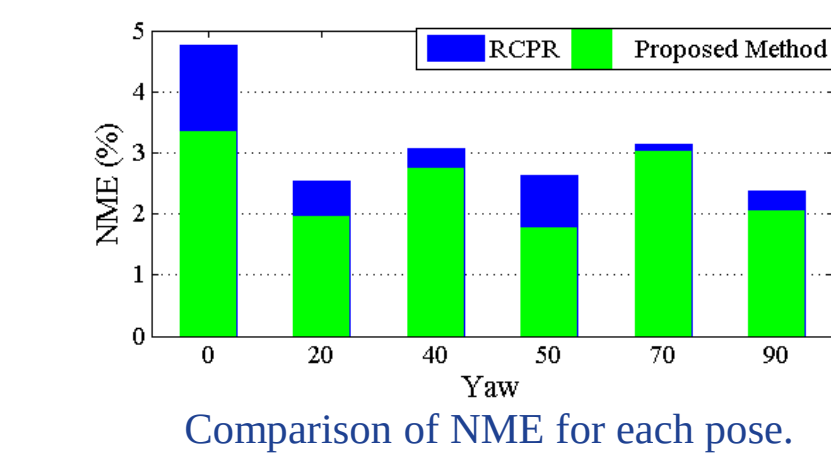


- The sign of z coordinate indicates 2D landmark visibility.

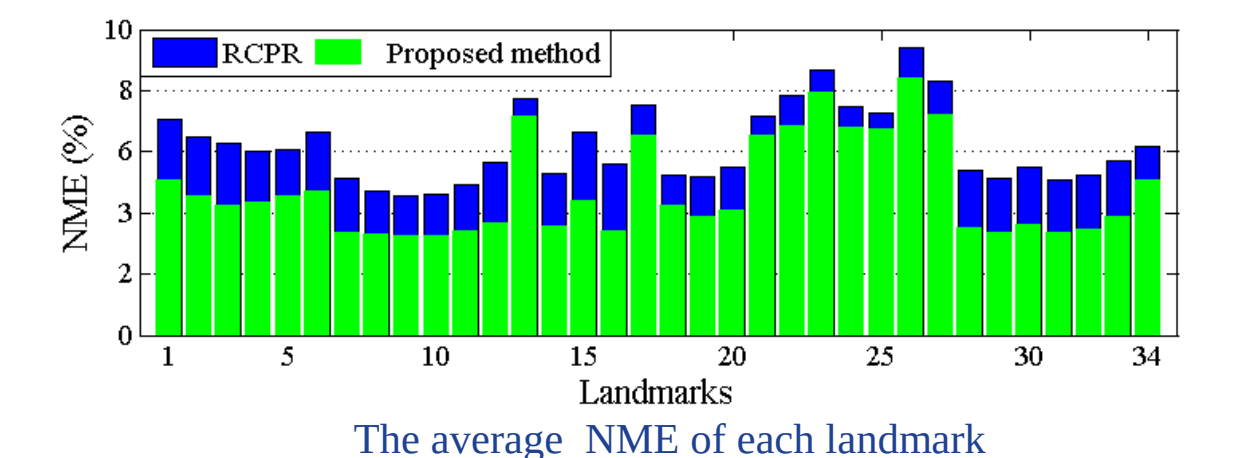
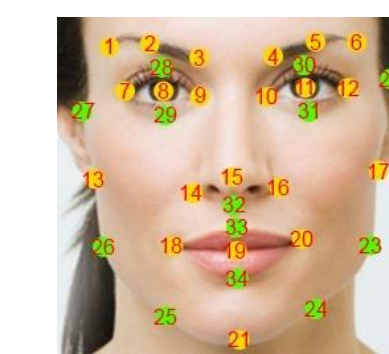
Experimental Results

AFLW dataset experiments

- 5200 images selected evenly within $[0^\circ, 30^\circ], [30^\circ, 60^\circ], [60^\circ, 90^\circ]$ yaw angles.
- Randomly partitioned into 3901 training and 1299 testing images.



The comparison of CED for different methods.



The average NME of each landmark

AFW dataset experiments

- 468 faces in 205 images with poses $\pm 90^\circ$.
- Labeled with up to 6 visible landmarks.

PAWF + Cheek Landmarks	D3PF + Cheek Landmarks	PIFA	CDM	TSPM
7.43	7.83	8.61	9.13	11.09



Result across stages



- Binary code: <http://cvlab.cse.msu.edu/project-pifa.html>

