

OpenFace: an open source facial behavior analysis toolkit

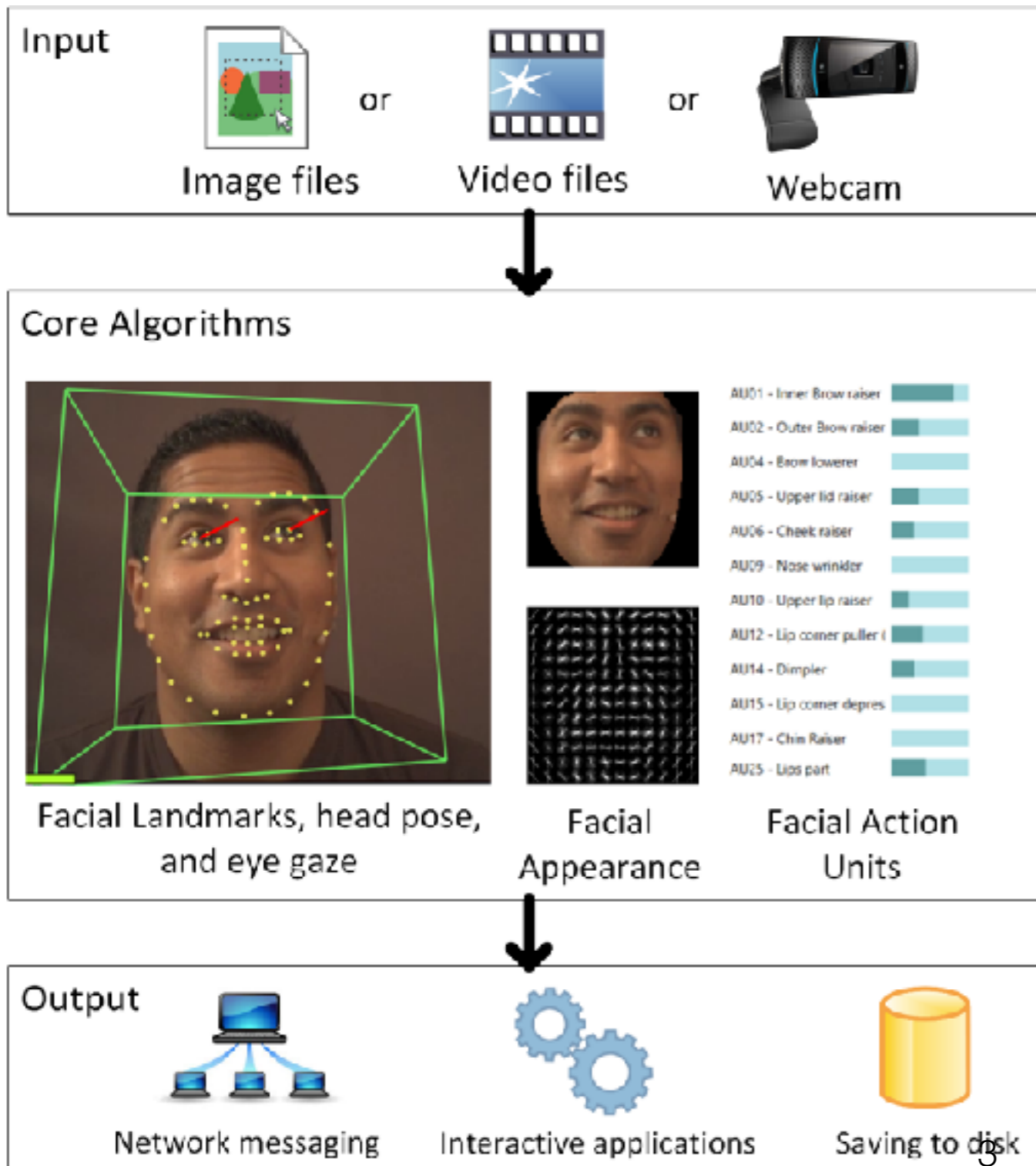
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Outline

- Introduction
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 - Landmark detection
 - Head pose tracking
 - Eye gaze estimation
 - Action Unit recognition
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Introduction

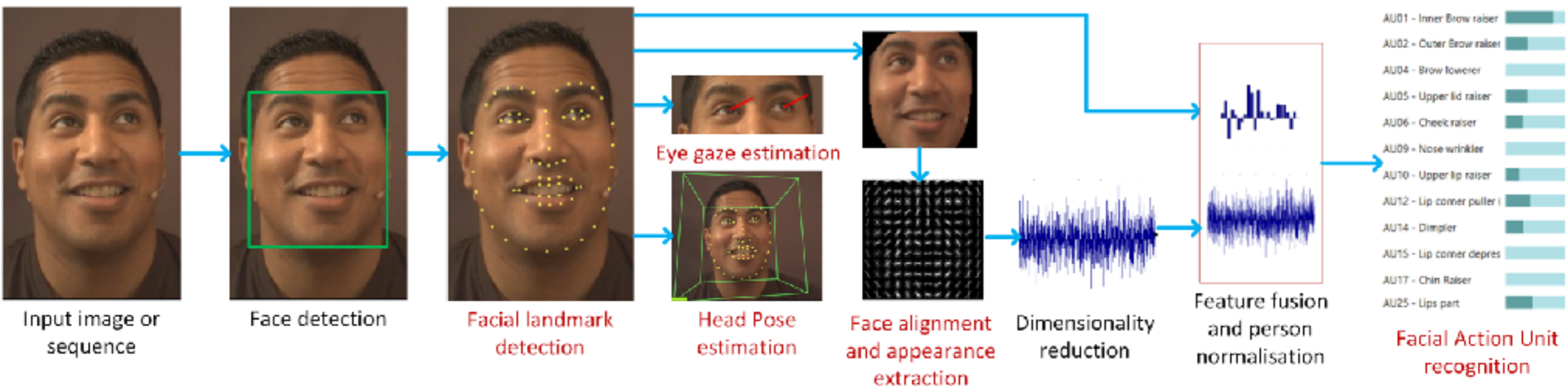


- First open source tool for facial behavior analysis
- Demonstrates state-of-the-art performance in facial landmark detection, head pose tracking, AU recognition and eye gaze estimation

Introduction

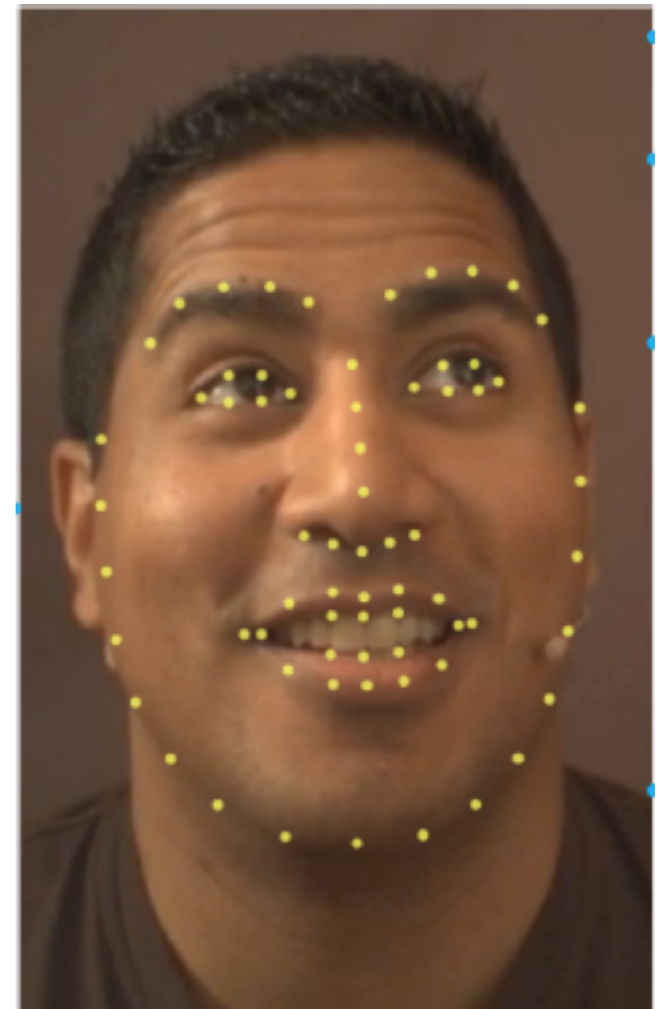
Tool	Approach	Landmark	Head pose	AU	Gaze	Train	Fit	Binary	Real-time
COFW [13]	RCPR [13]	✓				✓	✓		✓
FaceTracker	CLM [50]	✓	✓				✓	✓	✓
dlib [34]	[32]	✓				✓	✓		✓
DRMF [4]	DRMF [4]	✓	✓					✓	✓
Chehra	[5]	✓	✓					✓	✓
GNDPM	GNDPM [58]	✓						✓	
PO-CR [57]	PO-CR [57]	✓						✓	
Menpo [3]	AAM, CLM, SDM ¹	✓				✓	✓		²
CFAN [67]	[67]	✓						✓	✓
[65]	Reg. For [65]	✓	✓			✓	✓	✓	✓
TCDCN	CNN [70]	✓	✓					✓	✓
EyeTab	[63]				✓	N/A	✓	✓	✓
Intraface	SDM [64]	✓	✓					? ³	✓
OKAO	?	✓	✓	✓	✓			✓	
FACET	?	✓	✓	✓				✓	✓
Affdex	?	✓	✓	✓				✓	✓
Tree DPM [71]	[71]	✓				✓	✓		
LEAR	LEAR [40]	✓						✓	✓
TAUD	TAUD [31]			✓				✓	
OpenFace	[7, 6]	✓	✓	✓	✓	✓	✓	✓	✓

System Pipeline



Landmark detection

- Point Distribution Model (PDM) which captures landmark shape variations
- 68 facial landmarks
- Allows for detection of multiple faces

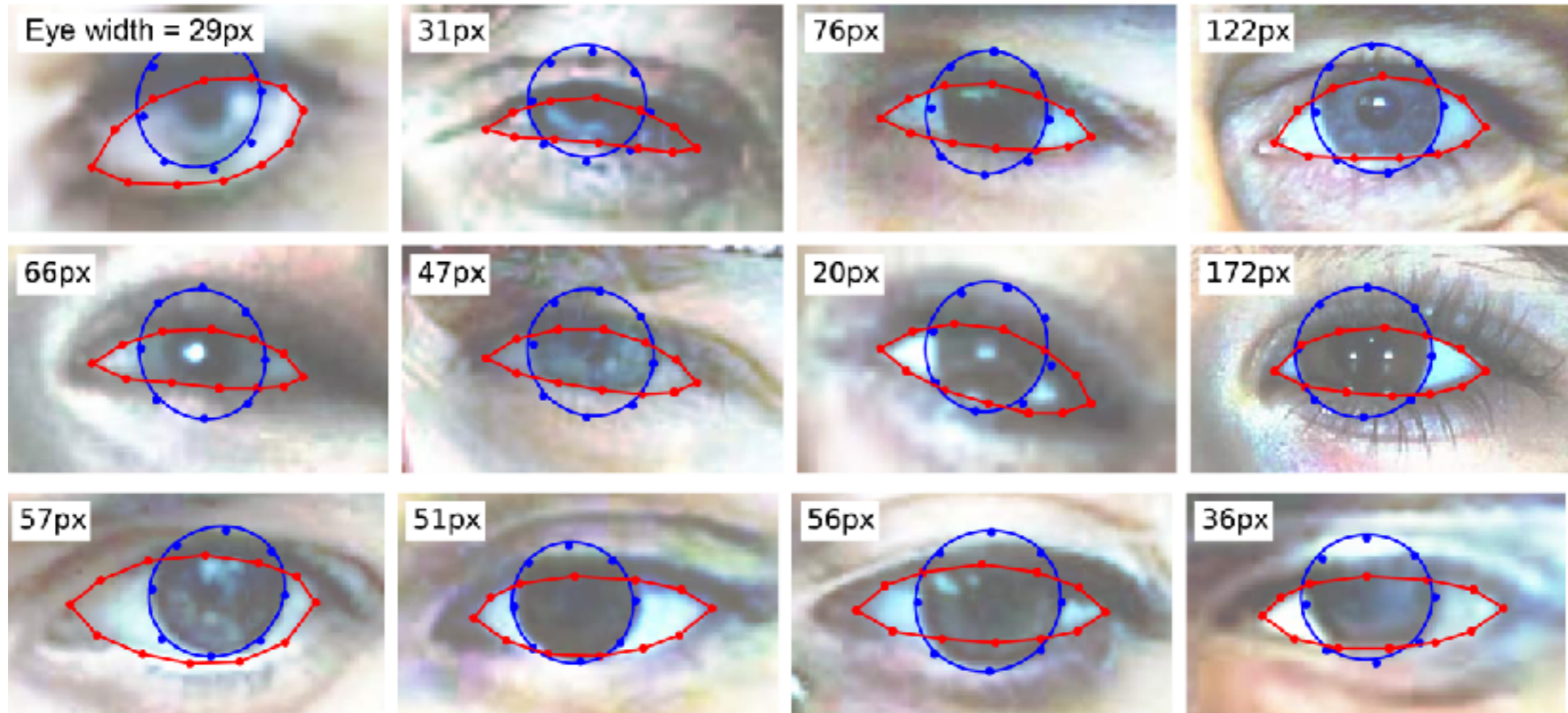


Facial landmark
detection

Head pose tracking

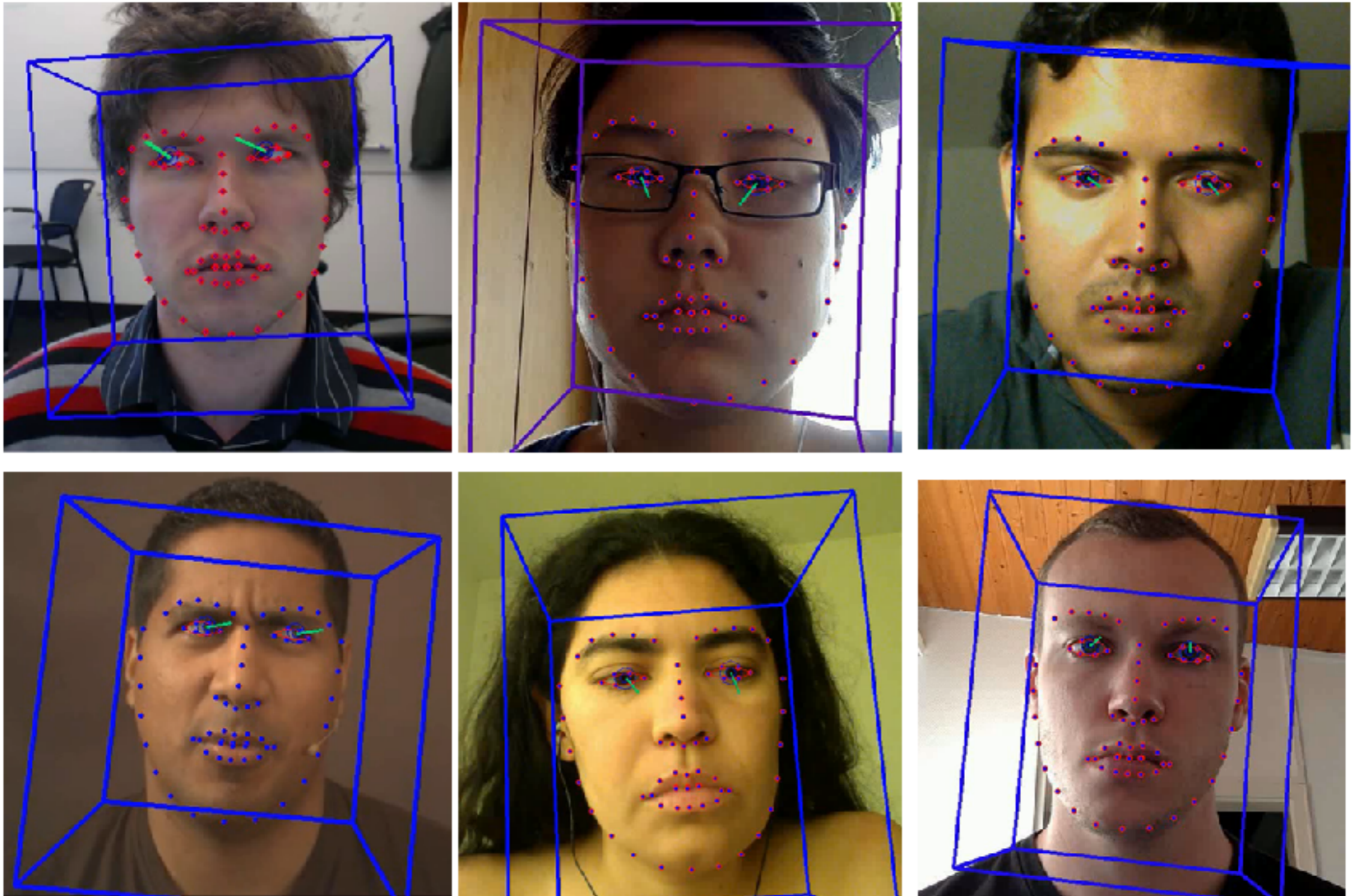
- Extract head pose (translation and orientation)
- Provided camera calibration parameters (focal length and principal point) to get better accuracy

Eye gaze estimation

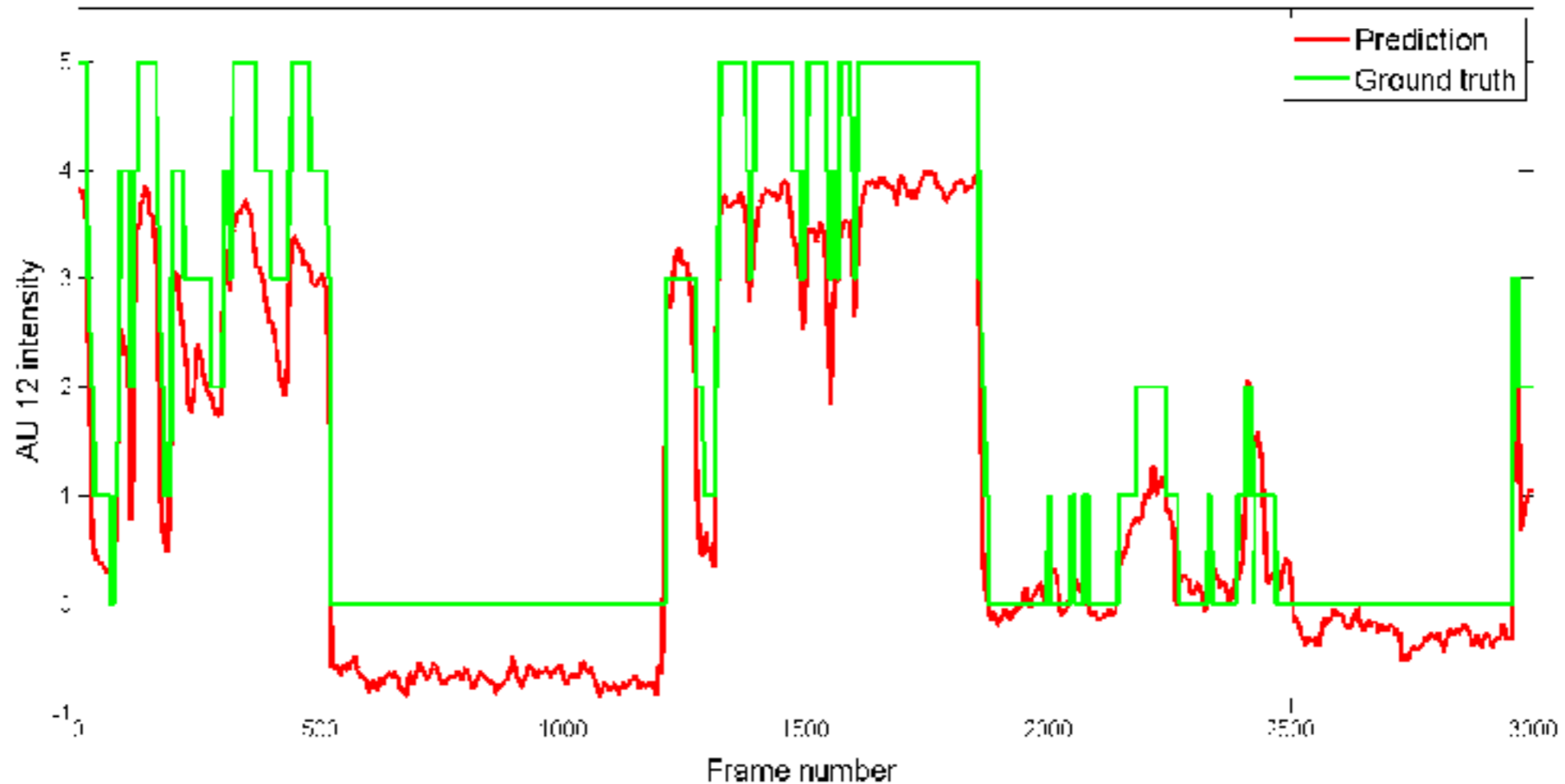


- The vector from the 3D eyeball center to the pupil location is our estimated gaze vector

Eye gaze estimation



Action Unit recognition



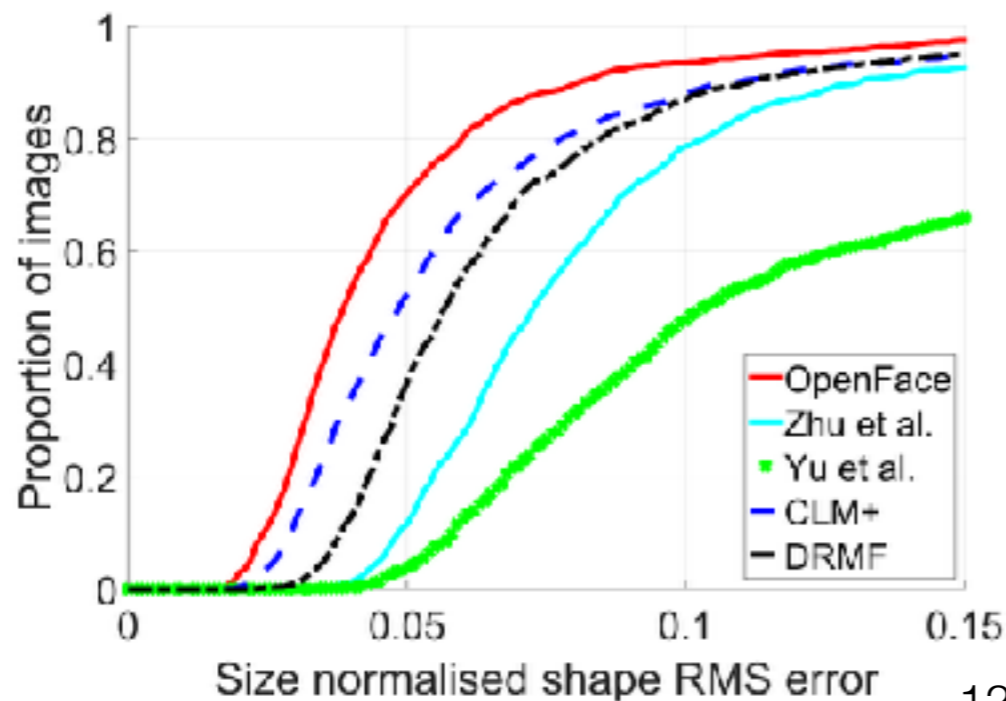
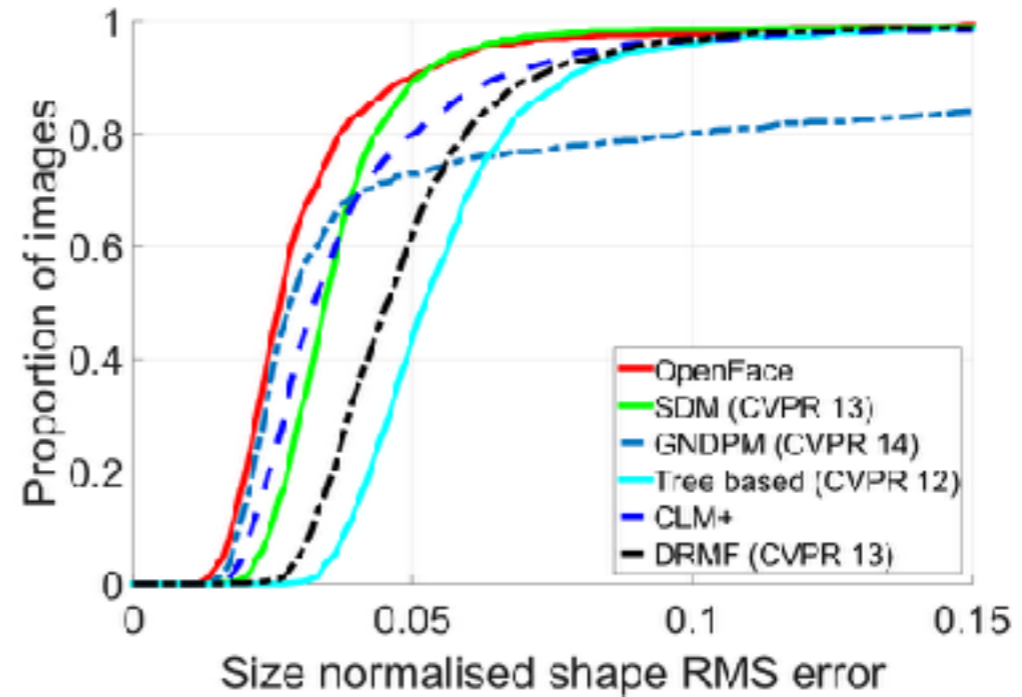
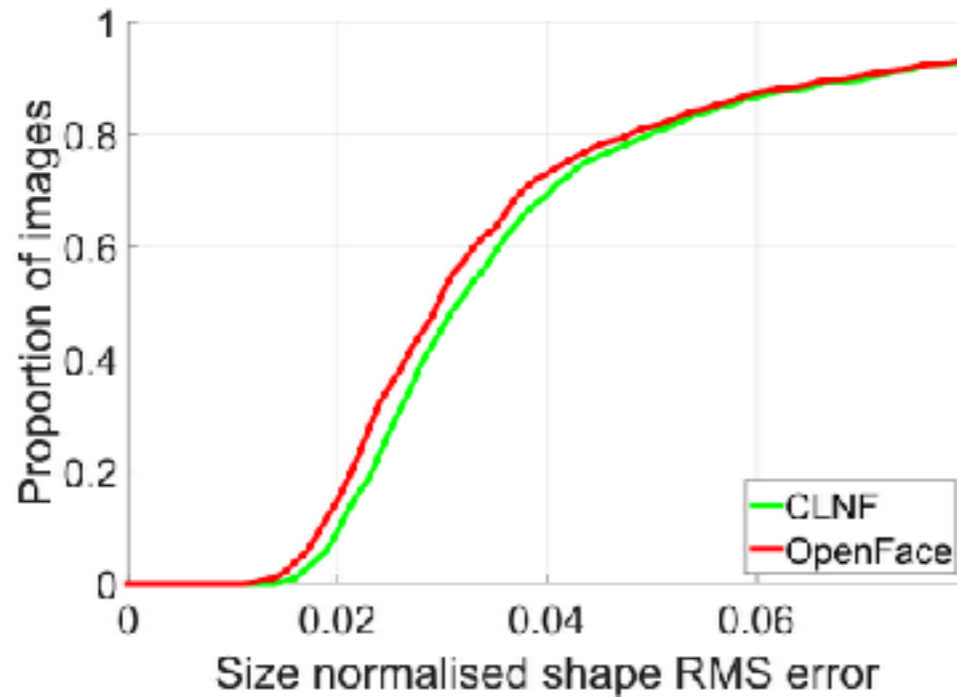
- Existing AU predictors tend to sometimes under- or over-estimate AU values for a particular person

Action Unit recognition

- Combine datasets of action unit presence and intensities
- Use a linear SVM and a linear SVR

AU	Full name	Prediction
AU1	Inner brow raiser	I
AU2	Outer brow raiser	I
AU4	Brow lowerer	I
AU5	Upper lid raiser	I
AU6	Cheek raiser	I
AU7	Lid tightener	P
AU9	Nose wrinkler	I
AU10	Upper lip raiser	I
AU12	Lip corner puller	I
AU14	Dimpler	I
AU15	Lip corner depressor	I
AU17	Chin raiser	I
AU20	Lip stretched	I
AU23	Lip tightener	P
AU25	Lips part	I
AU26	Jaw drop	I
AU28	Lip suck	P
AU45	Blink	P

Experiment



Landmark detection

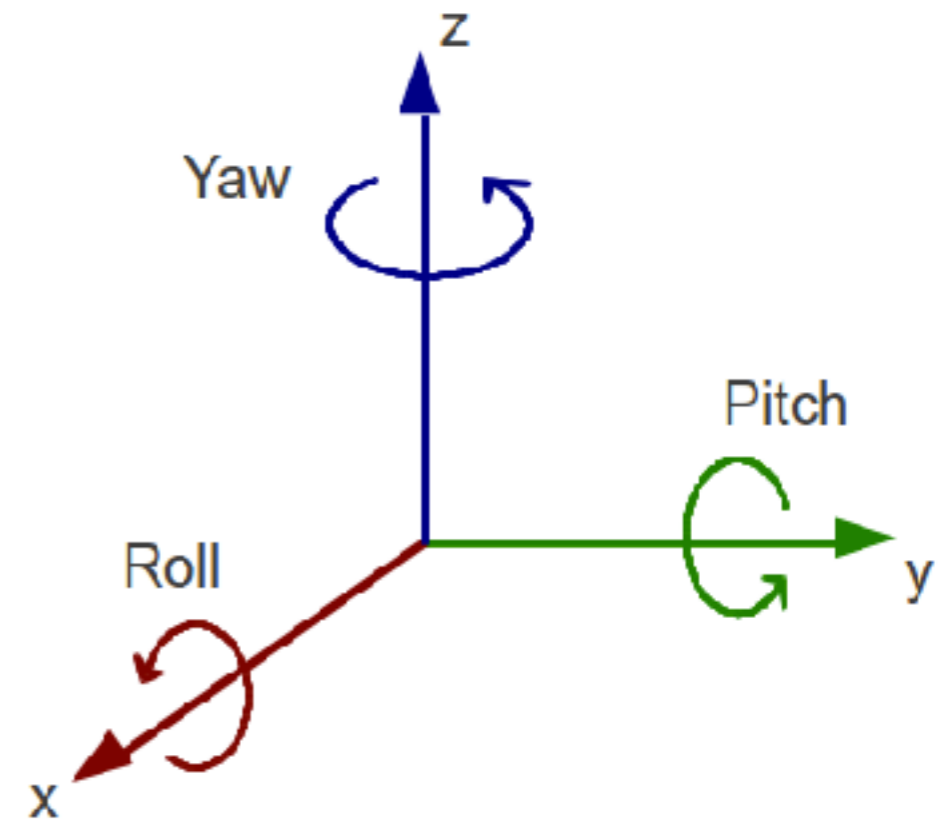
Experiment

Head pose tracking

Method	Yaw	Pitch	Roll	Mean
Reg. forests [22]	7.2	9.4	7.5	8.0
CLM-Z [9]	5.1	3.9	4.6	4.6
CLM [50]	4.8	4.2	4.5	4.5
Chehra [5]	13.9	14.7	10.3	13.0
OpenFace	3.6	3.6	3.6	3.6

Method	Yaw	Pitch	Roll	Mean	Median
Reg. forests [22]	9.2	8.5	8.0	8.6	N/A
CLM [50]	8.2	8.2	6.5	7.7	3.3
CLM-Z [9]	8.0	6.1	6.0	6.7	3.2
Chehra [5]	13.9	14.7	10.2	12.9	5.4
OpenFace	7.9	5.6	4.5	6.0	2.6

Method	Yaw	Pitch	Roll	Mean	Median
CLM [50]	3.0	3.5	2.3	2.9	2.0
Chehra [5]	3.8	4.6	2.8	3.8	2.5
OpenFace	2.8	3.3	2.3	2.8	2.0



Experiment

MODEL	GAZE ERROR
EyeTab [63]	47.1
CNN on UT [68]	13.91
CNN on SynthesEyes [62]	13.55
CNN on SynthesEyes + UT [62]	11.12
OpenFace	9.96

Eye gaze estimation

Experiment

	BP4D											SEMAINE						
AU	1	2	4	6	7	10	12	14	15	17	23	2	12	17	25	28	45	Mean
BG [59]	0.19	0.19	0.20	0.65	0.80	0.80	0.80	0.72	0.24	0.31	0.32	0.57	0.60	0.09	0.45	0.25	0.40	0.45
BA [59]	0.18	0.16	0.23	0.67	0.75	0.80	0.79	0.67	0.14	0.25	0.24	0.76	0.52	0.07	0.40	0.01	0.21	0.40
DL [28]	0.40	0.35	0.32	0.72	0.78	0.80	0.79	0.68	0.23	0.37	0.31	0.37	0.71	0.07	0.60	0.04	0.26	0.46
OF	0.26	0.25	0.25	0.73	0.80	0.84	0.82	0.72	0.34	0.33	0.34	0.41	0.57	0.20	0.69	0.26	0.42	0.48

Action Unit recognition

Conclusion

- A first fully open source real-time facial behavior analysis system
- Capable of facial landmark detection, head pose estimation, facial action unit recognition, and eye-gaze estimation
- Is able to run from a simple webcam