Investigating the Shift Invariance Mechanism of the Local Binary Pattern Operator for Facial Expression Recognition in an Automotive Environment

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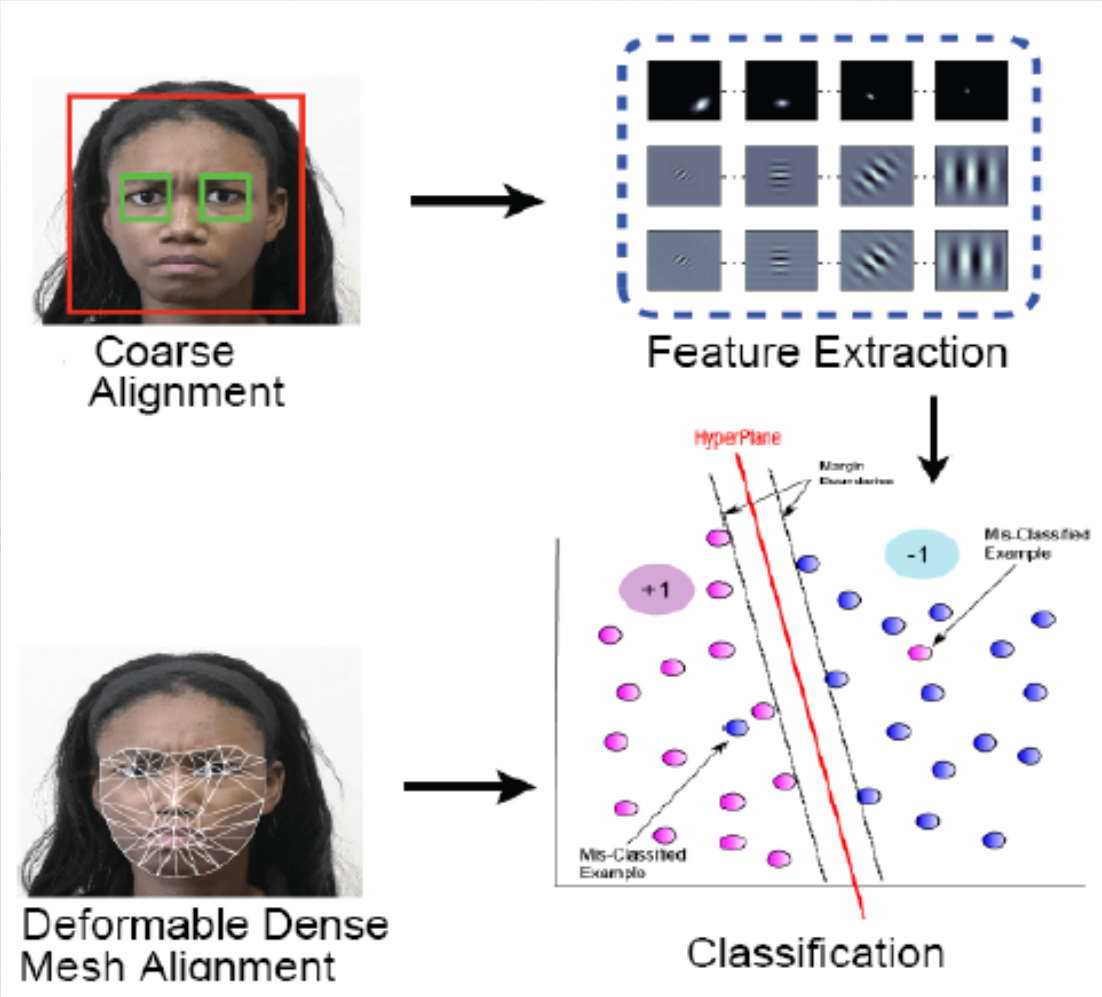
Facial Expressions of Drivers

- Facial expressions can convey plenty of information about a person's emotional state
- Happy, Sad, Angry, Fearful, Shocked, Disgusted?
- Can we use the driver's facial expressions to improve driving safety?

Expressions made by a driver while driving

Common Approach to Facial Expression Recognition



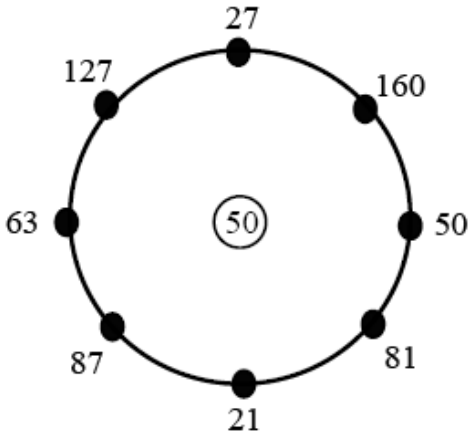
Appearance-based Features

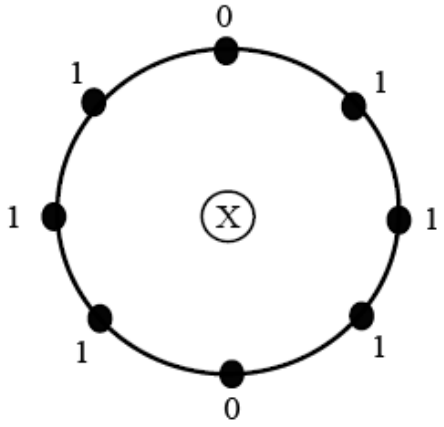
64	32	24
110	gc 50	100
86	49	96

64>gc 1	32<gc 0	24<gc 0
1	X	1
1	0	1

$$T = \sum_{P=0}^{P-1} t(g_P - g_c)2^P$$

$$t(:) = \begin{cases} 1 & \text{if } g_P \geq g_c \\ 0 & \text{otherwise.} \end{cases}$$





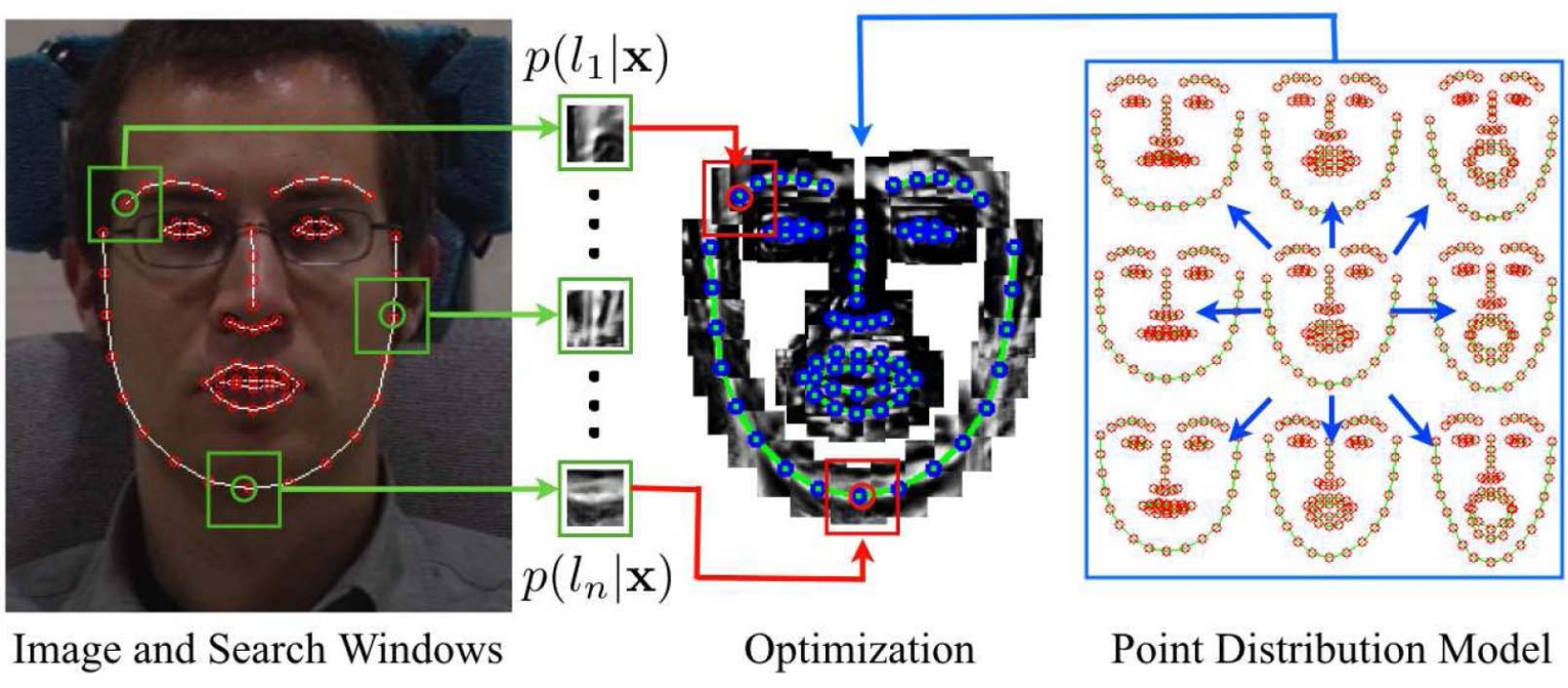
Local Binary Pattern Operators

- Encodes invariance to illumination changes
- **Also** encodes against shift variance

Deformable Dense Mesh Alignment

- Enforces good alignment between key landmarks
- Achieves this through accurate registration of the pixels
- Advantage: faster processing times (practical)

Constrained Local Models



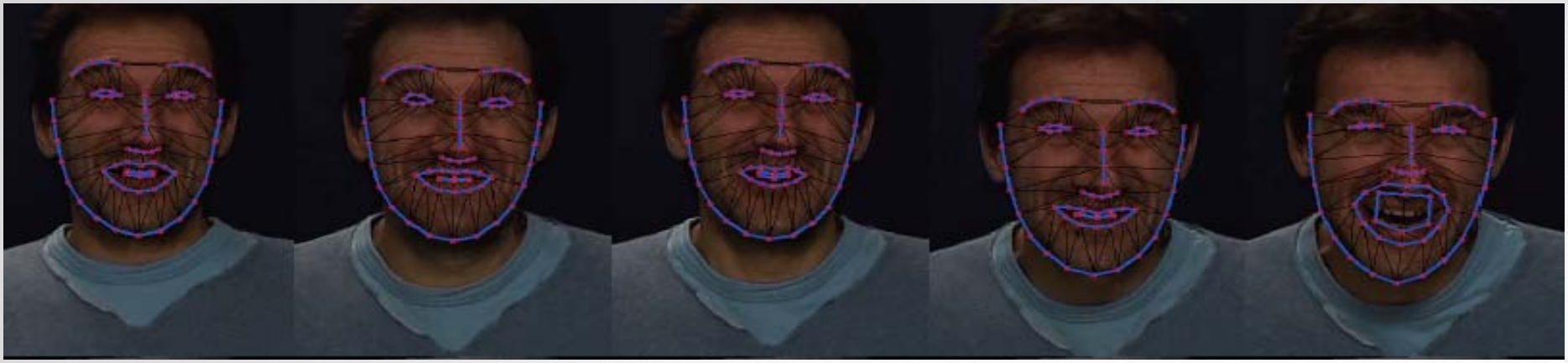
Are Features Required?

- Features require a large computational overhead (memory and processing time)
- Deformable Mesh Alignment techniques are able to achieve the same ends?
- Then what do these features do? Why are they needed?

Two Datasets

CK+

GEMEP-FERA



Comparison between Pixels and LBP (CK+)

AU	N	PIX-CAPP	PIX-SAPP	LBP-CAPP	LBP-SAPP
1	173	0.75	0.72	0.74	0.58
2	116	0.73	0.75	0.74	0.71
4	191	0.73	0.67	0.71	0.60
6	122	0.70	0.66	0.66	0.57
7	119	0.56	0.59	0.52	0.60
12	111	0.78	0.76	0.76	0.77
15	89	0.75	0.48	0.59	0.40
17	196	0.77	0.59	0.72	0.60
25	287	0.85	0.81	0.83	0.75
26	48	0.26	0.27	0.22	0.27
μ	–	0.73	0.67	0.70	0.62

Comparison between Pixels and LBP (GEMEP)

AU	N	PIX-CAPP	PIX-SAPP	LBP-CAPP	LBP-SAPP
1	1600	0.62	0.55	0.55	0.49
2	1631	0.55	0.47	0.47	0.47
4	1356	0.41	0.41	0.41	0.41
6	1808	0.69	0.65	0.63	0.63
7	2123	0.63	0.67	0.60	0.59
10	2034	0.60	0.60	0.56	0.56
12	2725	0.74	0.74	0.72	0.70
15	1026	0.34	0.43	0.33	0.37
17	822	0.30	0.27	0.29	0.27
18	419	0.33	0.26	0.23	0.17
25	812	0.31	0.30	0.30	0.30
26	499	0.20	0.22	0.20	0.20
μ	–	0.56	0.54	0.52	0.51

FERA Challenge Results

AU	Person-Independent	Person-Specific	Overall
1	**0.78** (0.63)	**0.53** (0.36)	**0.72** (0.57)
2	**0.72** (0.68)	**0.67** (0.40)	**0.71** (0.59)
4	**0.43** (0.13)	**0.64** (0.30)	**0.52** (0.19)
6	**0.66** (0.85)	**0.40** (0.26)	**0.60** (0.46)
7	**0.55** (0.49)	**0.64** (0.48)	**0.59** (0.49)
10	**0.47** (0.45)	**0.55** (0.53)	**0.50** (0.48)
12	**0.78** (0.77)	**0.75** (0.69)	**0.77** (0.74)
15	**0.16** (0.08)	**0.16** (0.20)	**0.16** (0.13)
17	**0.47** (0.38)	**0.30** (0.35)	**0.41** (0.37)
18	**0.45** (0.13)	**0.42** (0.24)	**0.44** (0.18)
25	**0.31** (0.80)	**0.22** (0.81)	**0.27** (0.80)
26	**0.54** (0.37)	**0.27** (0.47)	**0.43** (0.42)
μ	**0.53** (0.45)	**0.46** (0.42)	**0.51** (0.45)

What's the use of LBP then?

Problem of Illumination

Illumination changes as car travels to different locations

Head pose changes as driver focuses attention on different objects

Questions?

Thank You!