Skin Detection for SHRP2 Face Video

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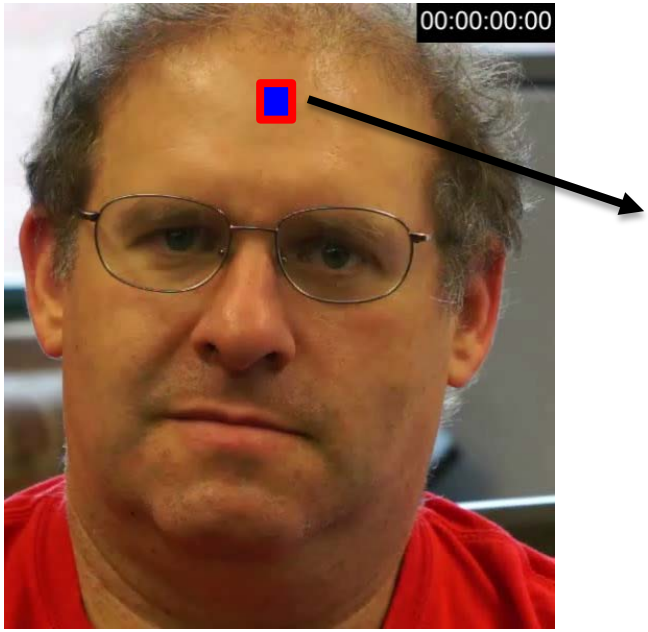
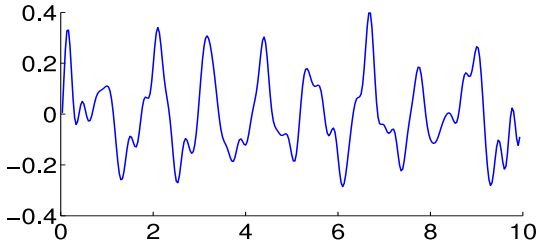
Motivation

- Remote measurement of heart rate from face video





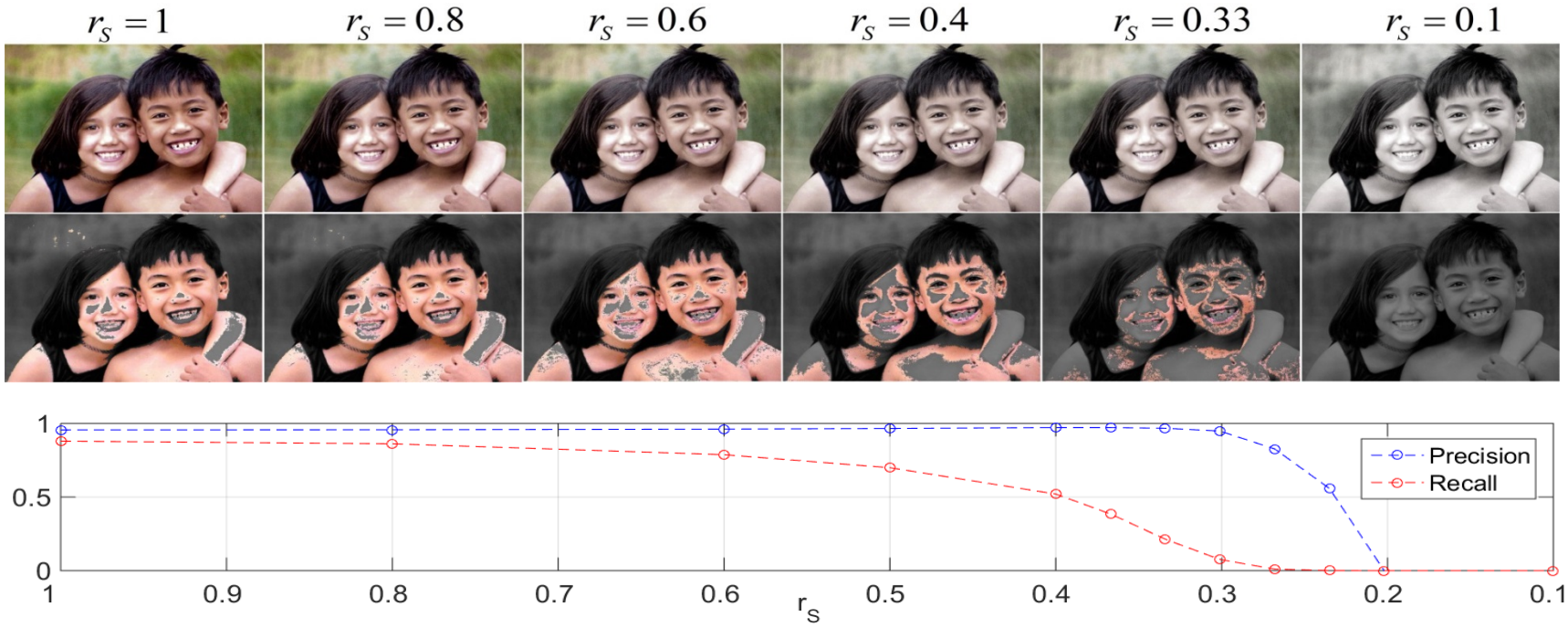
Wu et al. SIGGRAPH 2012

Motivation

- Driver attributes
  - Soft biometrics
  - Wearables
- Driver behavior analysis
  - Head pose
  - Emotion analysis
- Face Segmentation and tracking
- Limb detection – Activity recognition
- Face de-identification

Motivation

- Traditional skin detectors depends on color cues.
- SHRP2 data does not have color information.
- NextGen - Night time NIR video is grayscale.

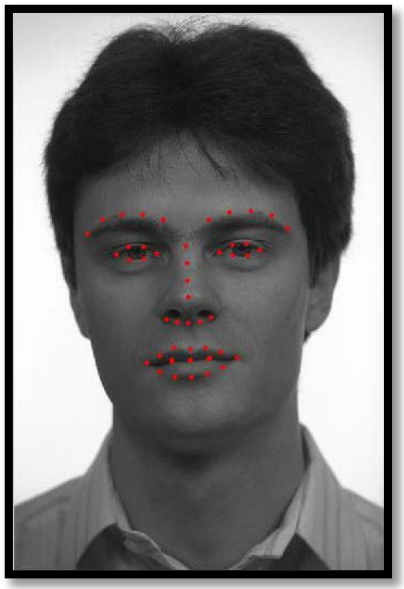


Motivation

- Presence of color
- Appearance of human skin varies for different intrinsic and extrinsic factors
- Human observers are adept at using textural and contextual cues
- We need a universal skin detector
- Image based skin detection
- Use contextual information

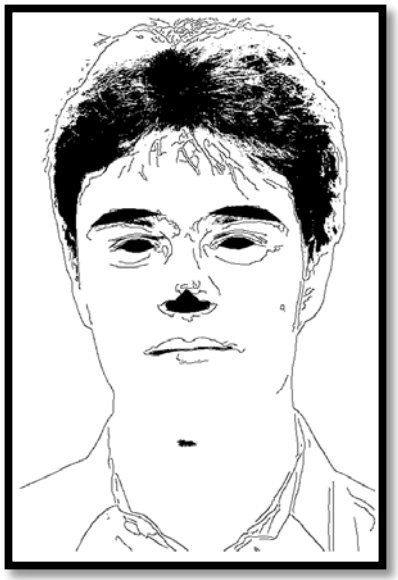
Grayscale skin detection

- Learn local statistics to understand global skin characteristics.

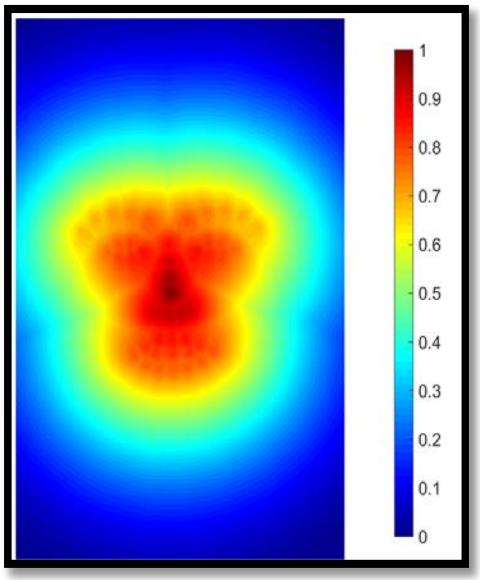


Face detection of grayscale image

Skin MASK

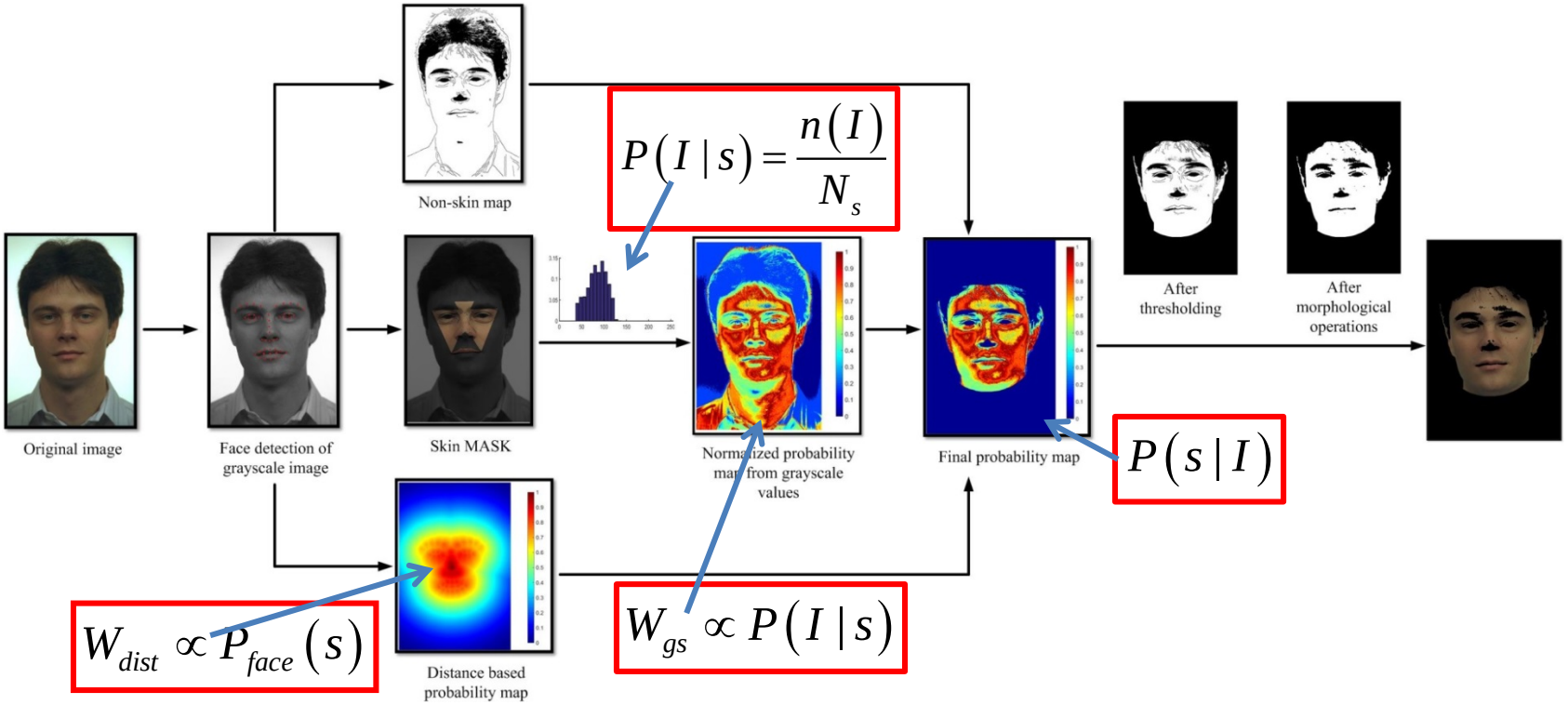


Non-skin map



Distance based probability map

Grayscale skin detection

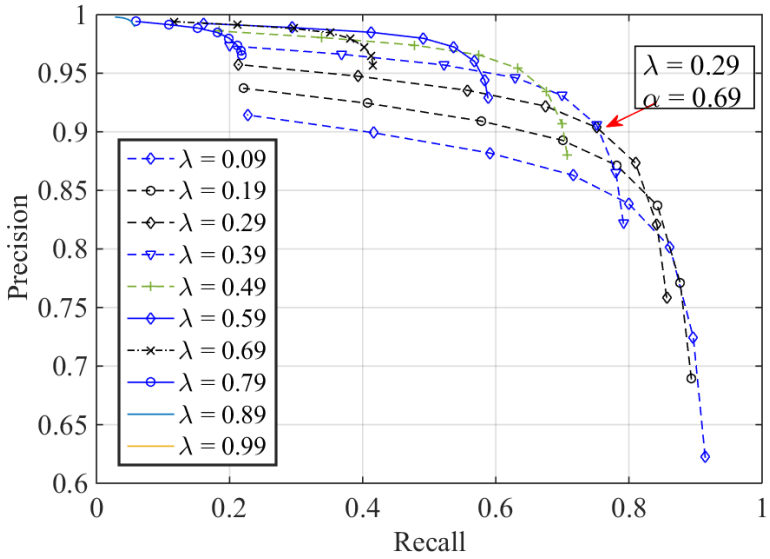


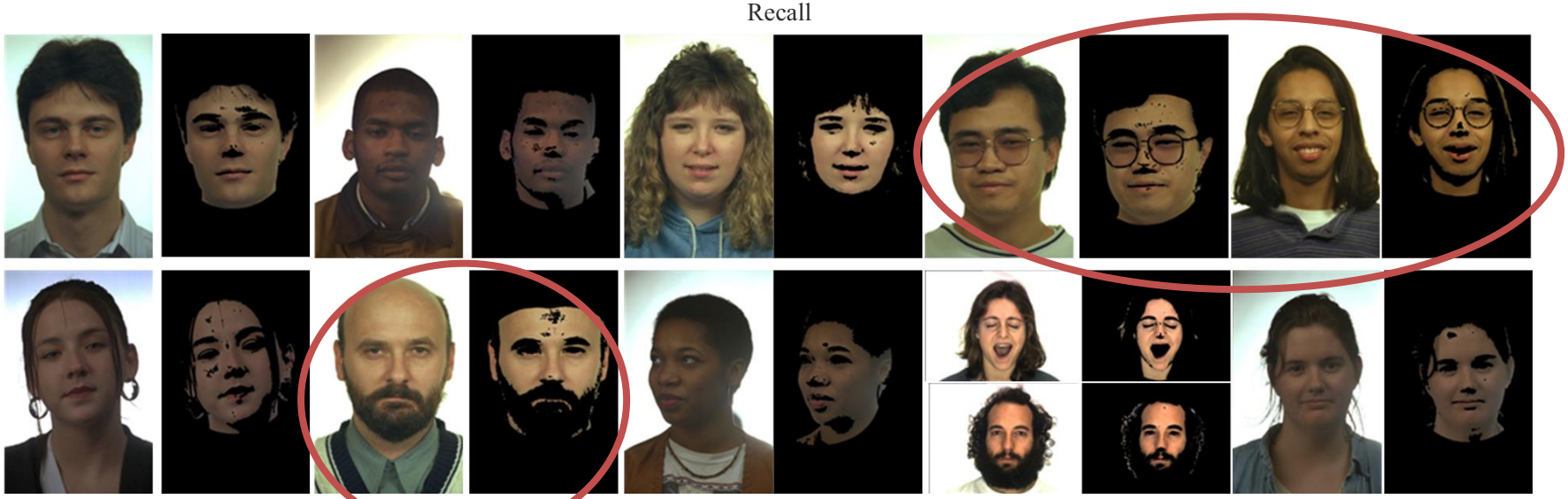
$$P(s|I) \propto P(I|s)\left[P_{face}(s)\right]^{\alpha}$$
$$\propto W_{gs}\left[W_{dist}(s)\right]^{\alpha}$$

Experiments and results

- We have used SFA dataset
  - Dataset comprises of images from different age, sex, skin tone and facial hair and accessories.
  - Tested on 1000 images
  - Face detector succeeded for 890 images
  - Original color images are converted to grayscale

Face skin detection: Indoor





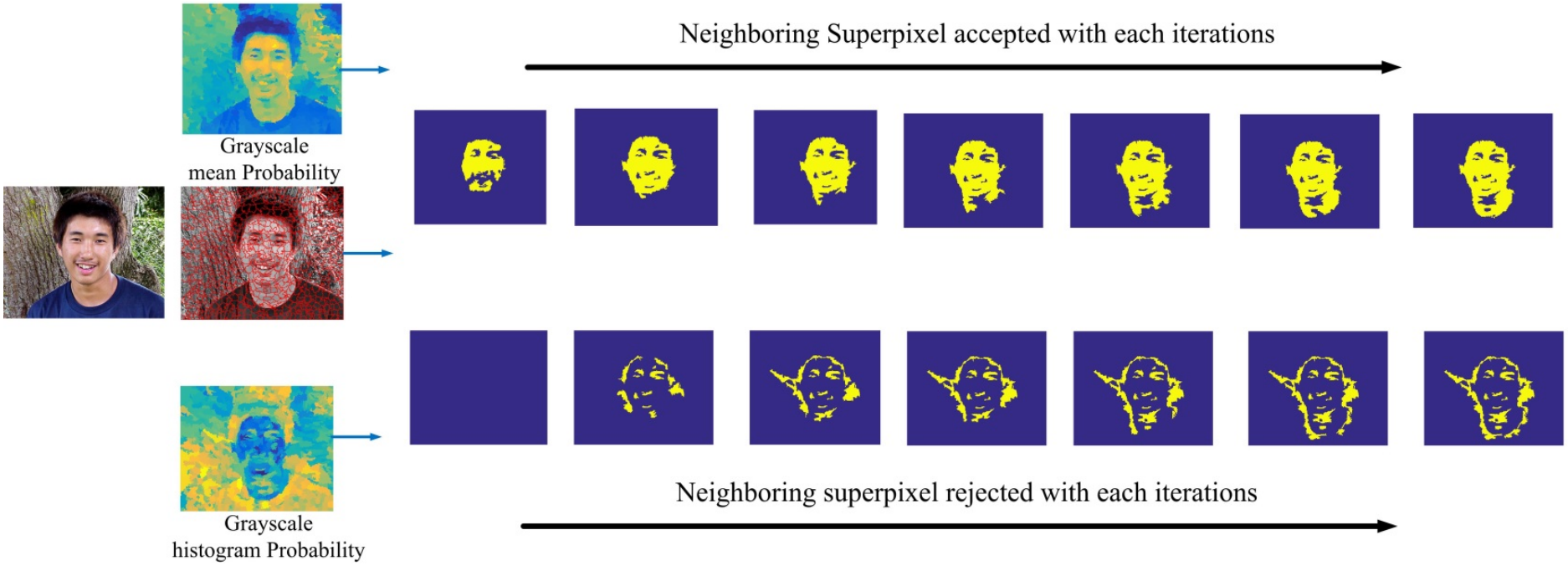
Face skin detection: Drivers

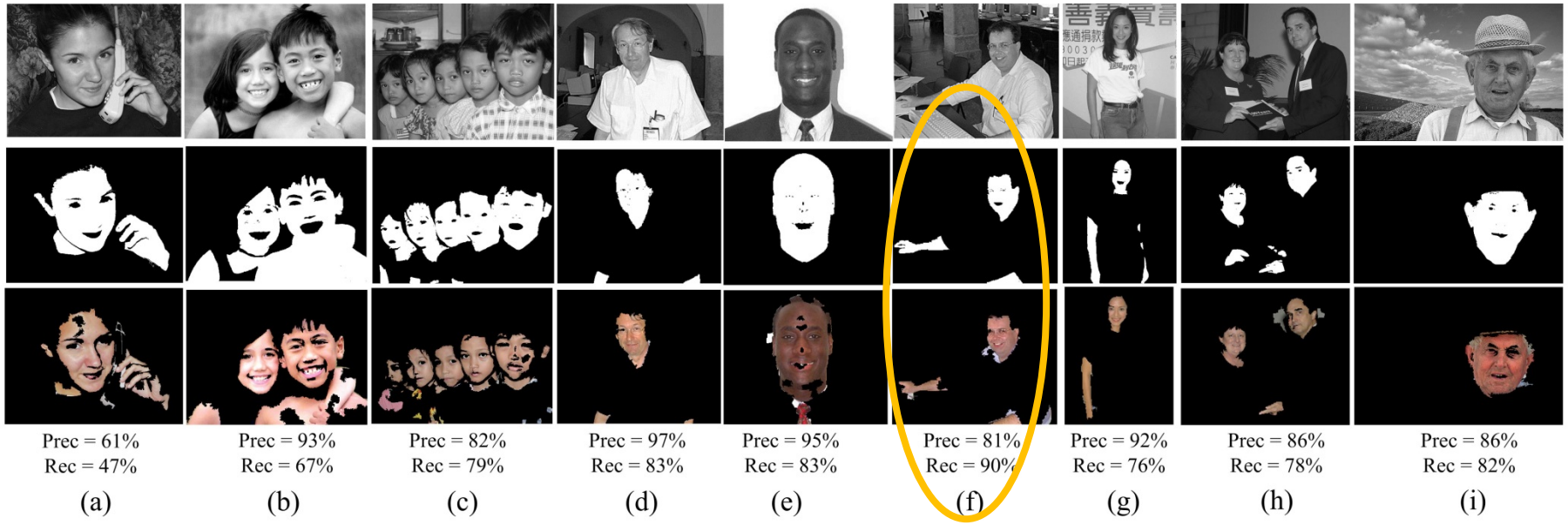
- We have tested for different head pose

Face skin detection: Drivers

Region Growing

- What about face segmentation and limb detection?
- We use a region growing algorithm that uses belief propagation from one Superpixel to its neighbor.





(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Prec = 61% Rec = 47%	Prec = 93% Rec = 67%	Prec = 82% Rec = 79%	Prec = 97% Rec = 83%	Prec = 95% Rec = 83%	Prec = 81% Rec = 90%	Prec = 92% Rec = 76%	Prec = 86% Rec = 78%	Prec = 86% Rec = 82%

(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
Prec = 95% Rec = 79%	Prec = 94% Rec = 79%	Prec = 73% Rec = 78%	Prec = 88% Rec = 95%	Prec = 79% Rec = 83%	Prec = 88% Rec = 92%	Prec = 79% Rec = 93%	Prec = 92% Rec = 74%	Prec = 94% Rec = 87%	Prec = 91% Rec = 72%

Challenges

Challenges

- Confusion with background, hair color
- Failure of face detector
- Illumination gradient

Conclusion

Contributions

- We have developed a standalone, universal skin detection algorithm
- First to our knowledge for grayscale images.
- Useful for driver monitoring and attribute detection

Future Direction

- Interactive skin segmentation
- Iterative method to improve face detection

Acknowledgements

- Review team – NDRS 2016
- Surface Transport Safety Center for Excellence (STSCE)
- Virginia Tech Transportation Institute

Image source - http://i.telegraph.co.uk/multimedia/archive/01398/young-driver_1398460c.jpg

Questions ?