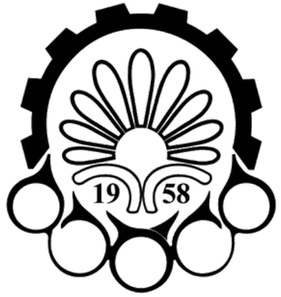


Amirkabir University of Technology
(Tehran Polytechnic)

Final project presentation

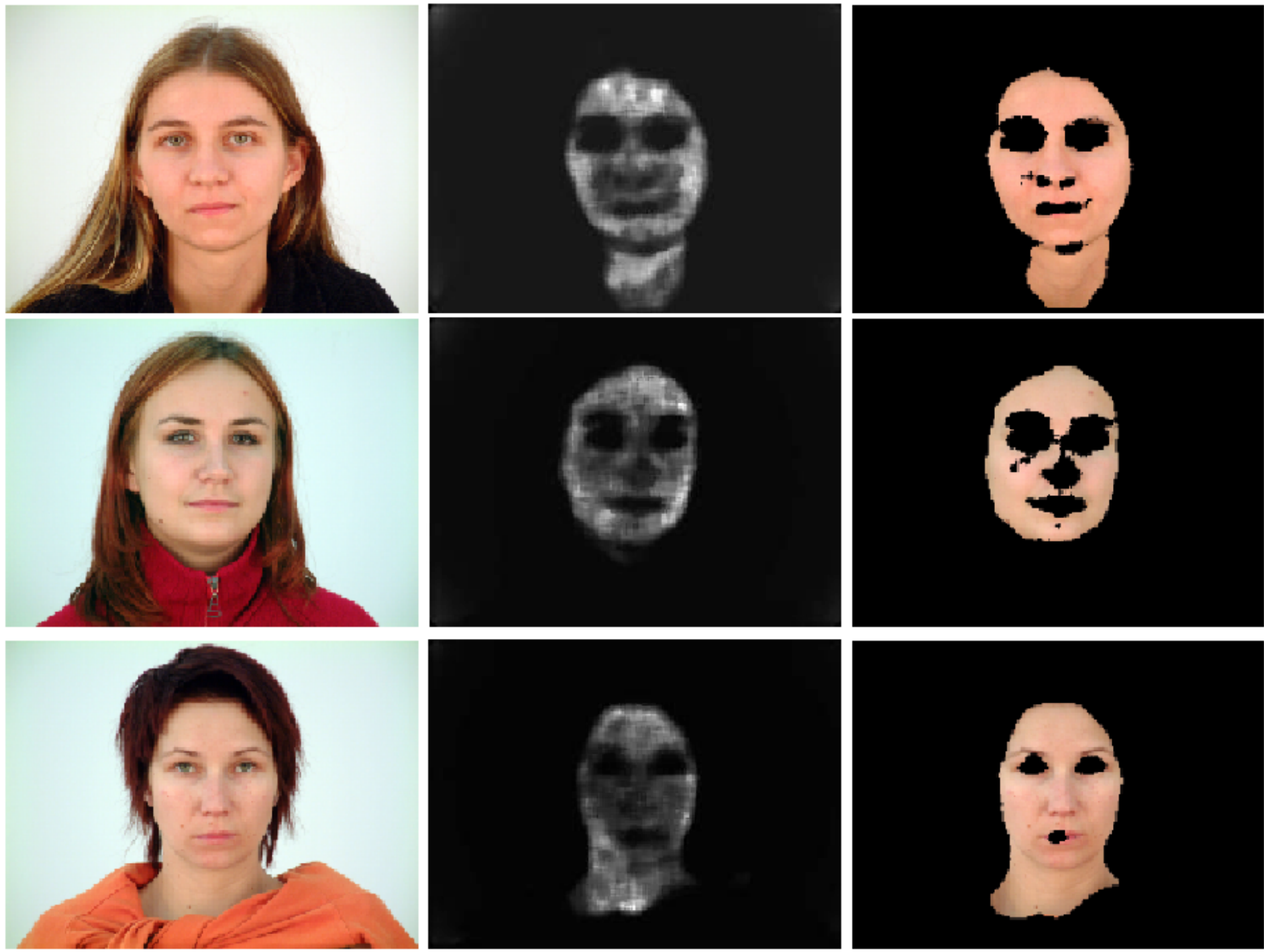
Spatial-based skin detection

using discriminative skin presence features

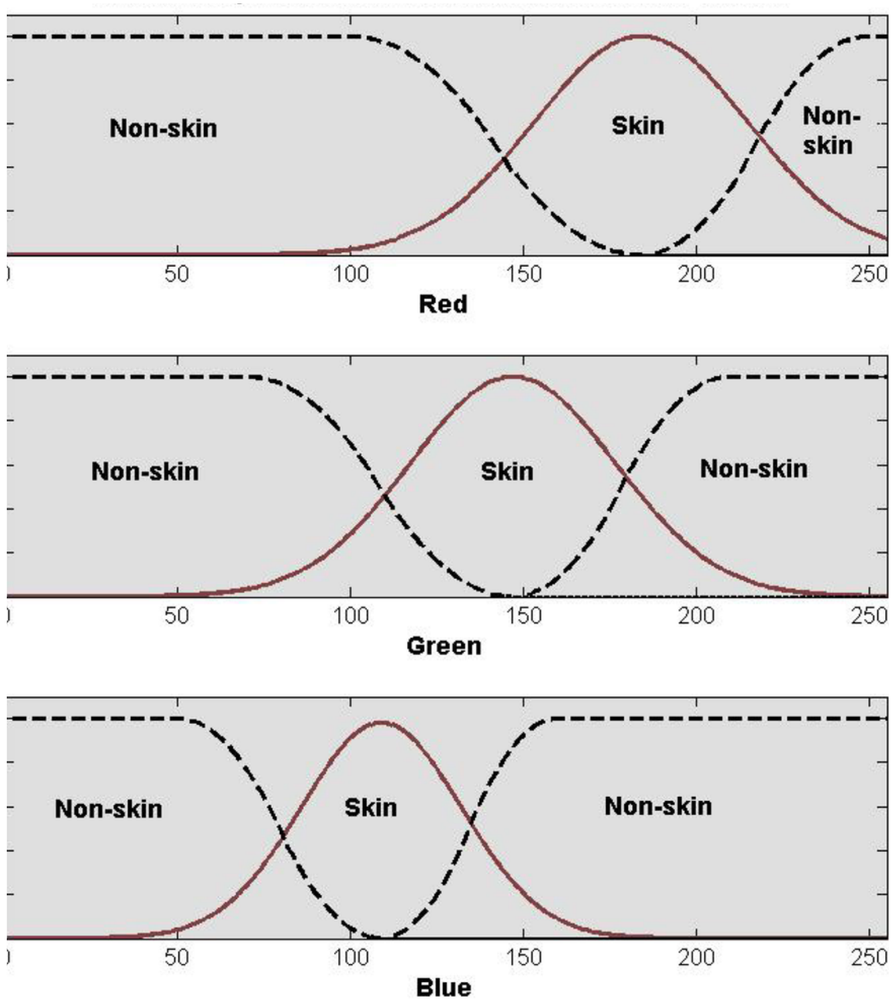
Digital image processing course | spring 2022

Presenter
Mohsen Ebadpour | M.Ebadpour@aut.ac.ir
MSc. Student in Computer Engineering(AI) at Amirkabir University of Technology(AUT)

Motivation of paper

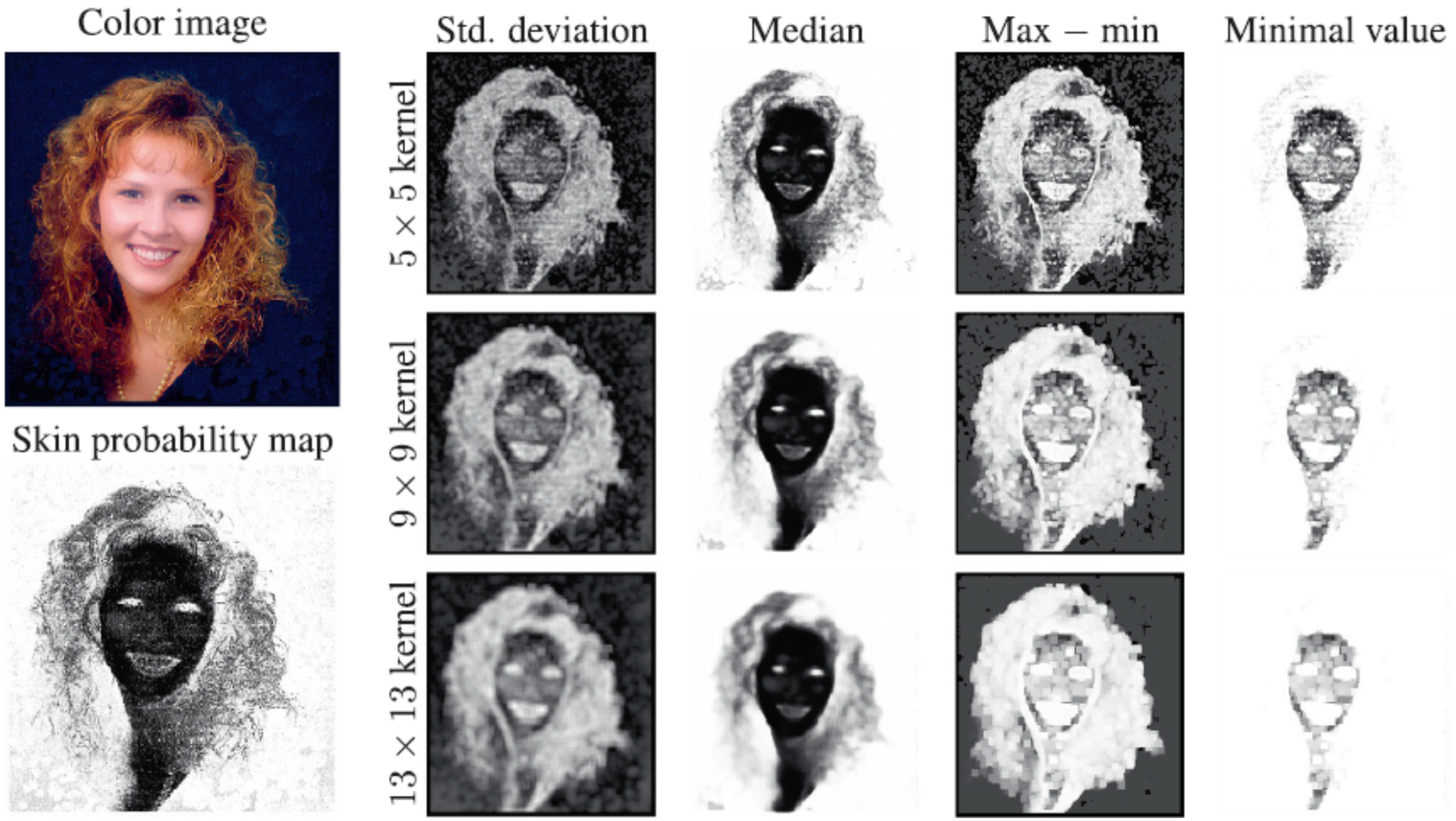


Bayesian Classifier

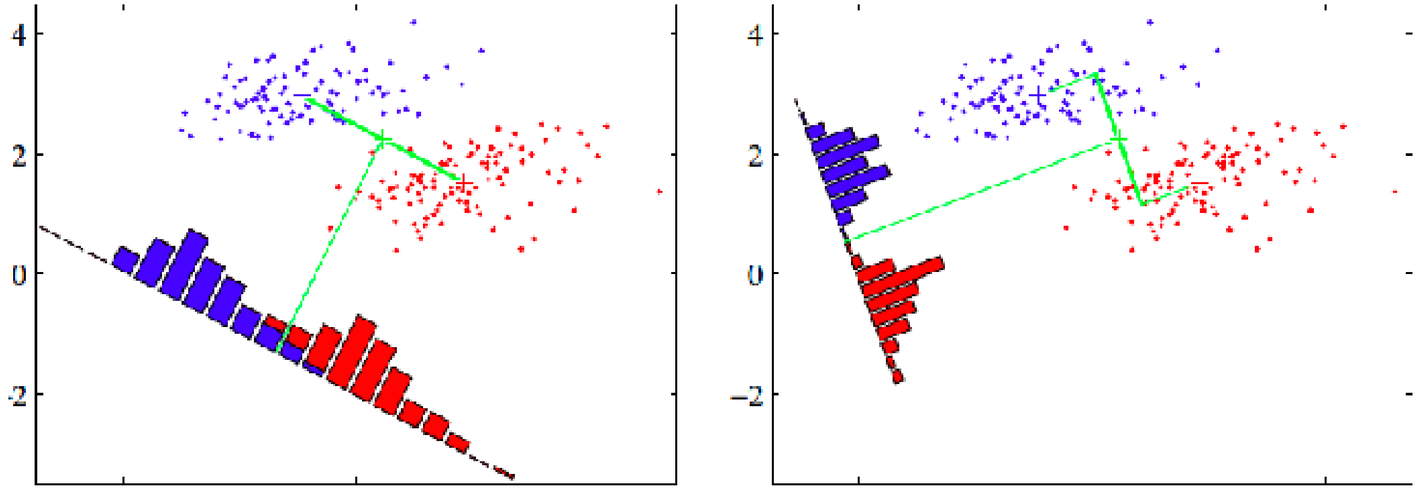


$$P(C_s|v) = \frac{P(v|C_s)P(C_s)}{P(v|C_s)P(C_s) + P(v|C_{ns})P(C_{ns})}$$

Basic Image Features(BIFs)



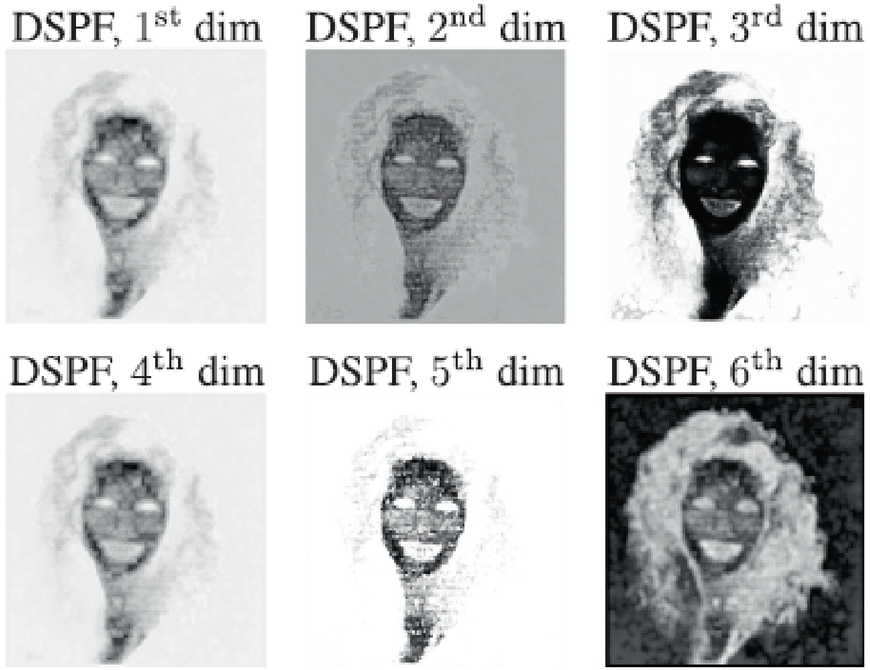
Linear discriminant analysis

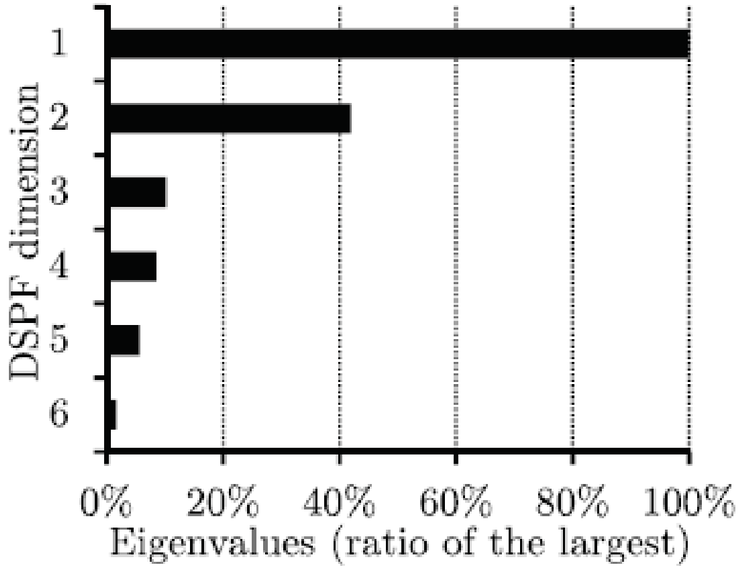


$$S_W = \sum_{i=1}^{K} \sum_{\boldsymbol{u}_k \in K_i} (\boldsymbol{u}_k - \boldsymbol{\mu}_i)(\boldsymbol{u}_k - \boldsymbol{\mu}_i)^T$$

$$S_B = \sum_{i=1}^{K} (\boldsymbol{\mu}_i - \boldsymbol{\mu})(\boldsymbol{\mu}_i - \boldsymbol{\mu})^T$$

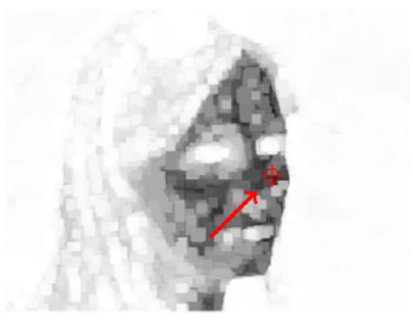
Discriminative skin-presence features(DSPFs)

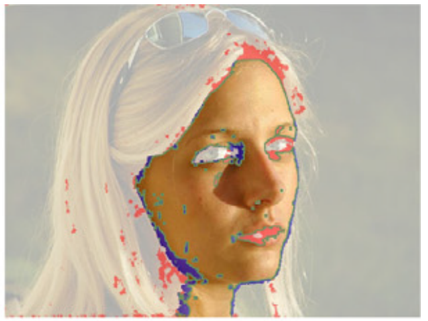




DSPF Skin map



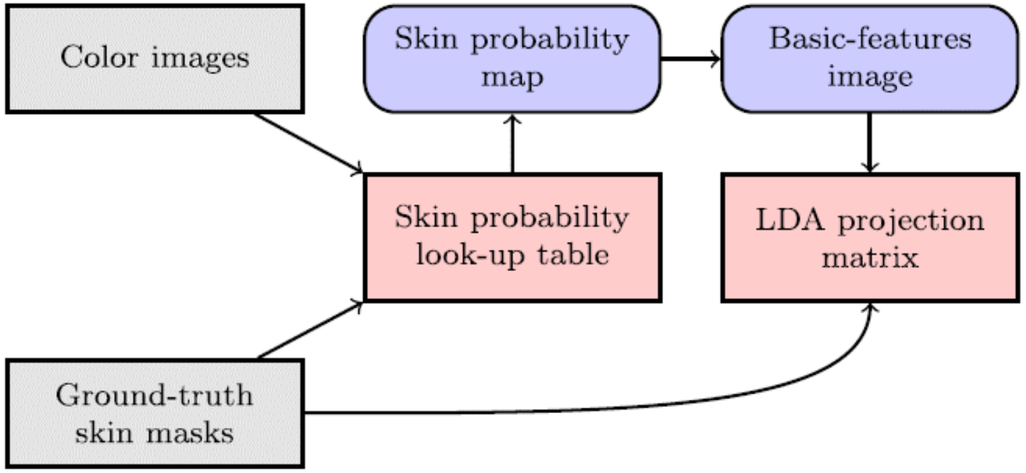




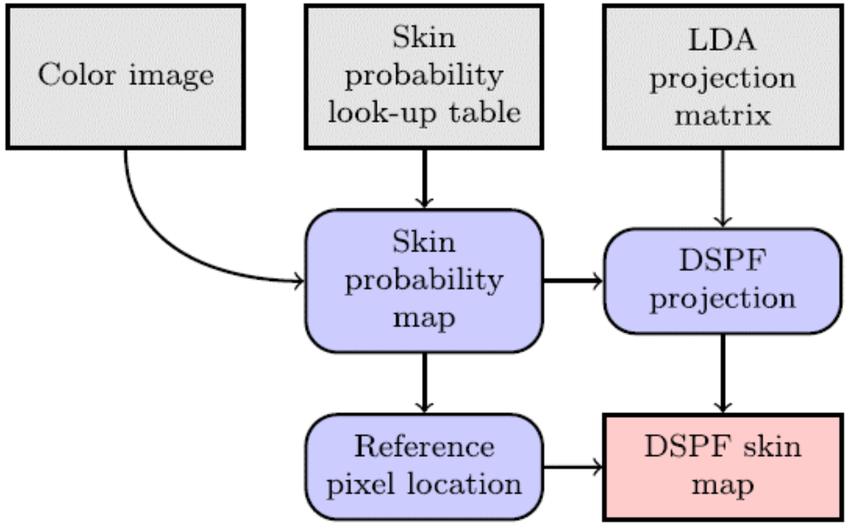
$$D(x) = \left[\sum_{i=1}^{m}\left(v_i^{(x)} - v_i^{(r)}\right)^2\right]^{1/2}$$

Flowchart of proposed idea

Training

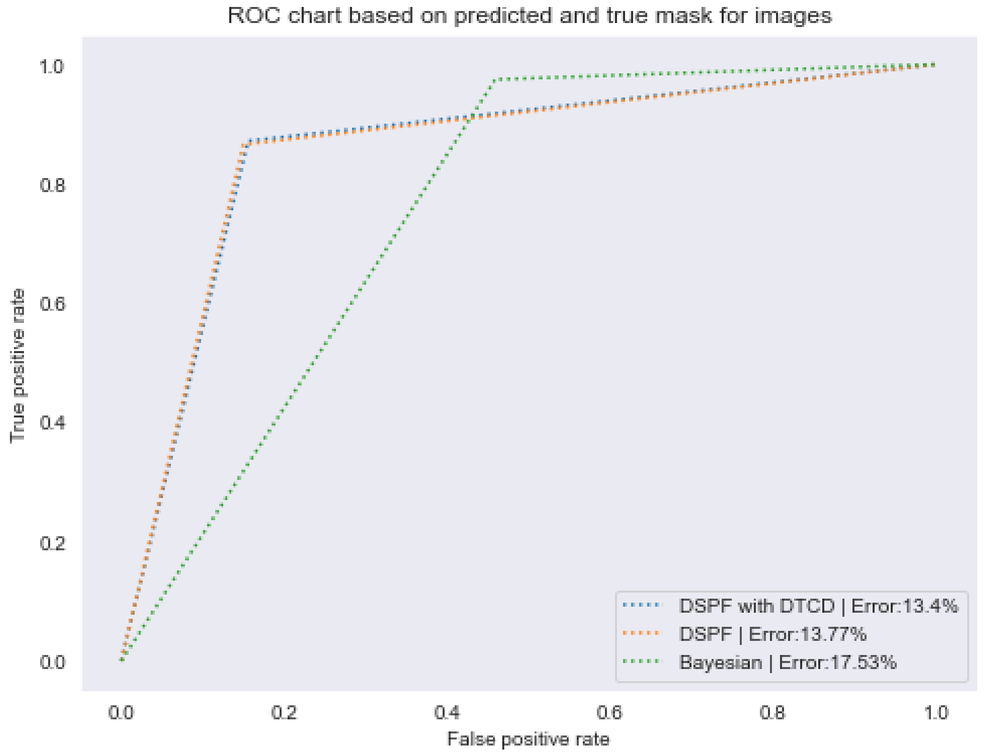


Testing



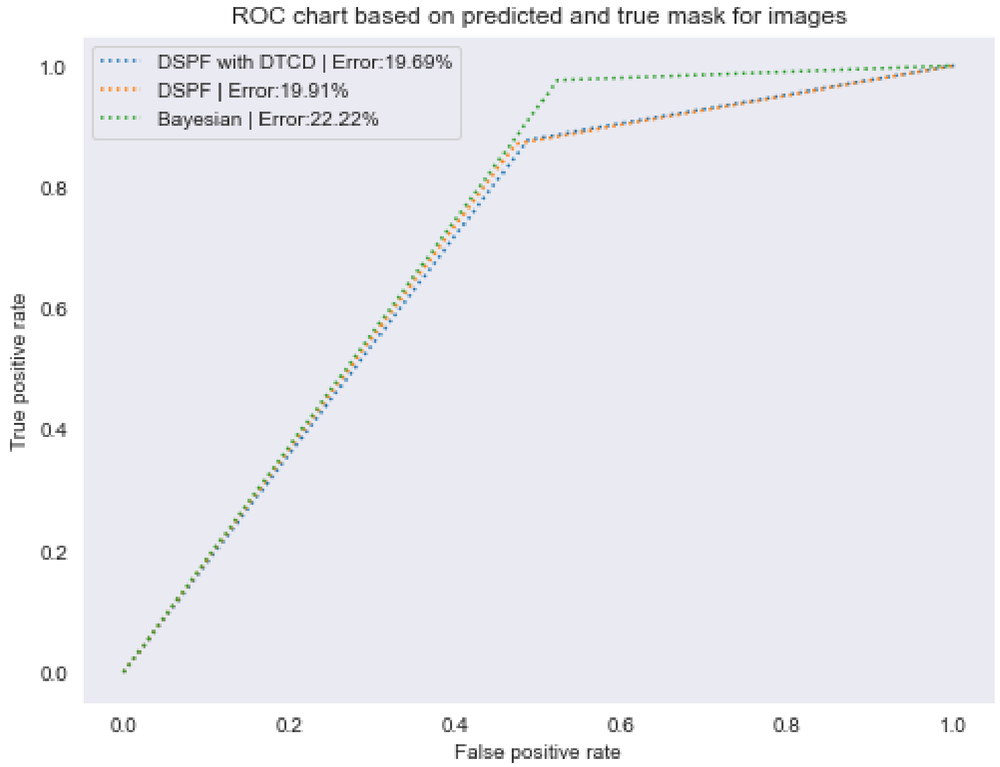
DSPF Skin map (result)

Method ↓	ECU data set						HGR data set					
	t (ms)	δ_{fn} (%)	δ_{fp} (%)	$\delta_{fp}^{(SE)}$ (%)	$\delta_{\min}$ (%)	G_{sa} (%)	t (ms)	δ_{fn} (%)	δ_{fp} (%)	$\delta_{fp}^{(SE)}$ (%)	$\delta_{\min}$ (%)	G_{sa} (%)
Bayes. class.	**6**	9.97	14.93	14.93	24.91	–	**4**	6.72	4.90	4.90	11.62	–
DSPF	257	9.65	11.48	10.49	21.14	–	176	6.17	4.30	2.15	10.47	–
with DTCD*	432	6.75	9.21	**7.01**	**15.96**	5.18	316	3.95	3.11	**1.60**	**7.06**	3.41



DSPF-L Skin map (result)

Method ↓	ECU data set						HGR data set					
	t (ms)	δ_{fn} (%)	δ_{fp} (%)	$\delta_{fp}^{(SE)}$ (%)	$\delta_{\min}$ (%)	G_{sa} (%)	t (ms)	δ_{fn} (%)	δ_{fp} (%)	$\delta_{fp}^{(SE)}$ (%)	$\delta_{\min}$ (%)	G_{sa} (%)
Bayes. class.	**6**	9.97	14.93	14.93	24.91	–	**4**	6.72	4.90	4.90	11.62	–
DSPF-L	273	19.96	15.78	15.41	35.75	–	181	24.50	7.21	2.45	31.71	–
with DTCD*	425	13.49	13.40	11.33	26.89	**8.86**	313	17.67	5.37	1.77	23.03	**8.68**



Spatial analysis of skin pixels using the distance transform

$$C(x) = \sum_{i=0}^{l-1} \rho(p_i \rightarrow p_{i+1}).$$

$$\rho(x \rightarrow y) = \rho_I(x,y) \cdot [1 + \rho_P(x \rightarrow y)],$$

$$\rho_I(x,y) = \alpha_{diag} \cdot (|Y(x) - Y(y)| + |H(x) - H(y)|),$$

$$\rho_P(x \rightarrow y) = \begin{cases} 1 - D_N(y) & \text{for } D_N(y) > P_\beta, \\ \infty & \text{for } D_N(y) \leqslant P_\beta. \end{cases}$$

Fast propagation-based skin regions segmentation in color images

Michal Kawulok

***Abstract*— This paper introduces a new method for skin regions segmentation which consists in spatial analysis of skin probability maps obtained using pixel-wise detectors. There are a number of methods which use various techniques of skin color modeling to classify every individual pixel or transform input color images into skin probability maps, but their performance is limited due to high variance and low specificity of the skin color. Detection precision can be enhanced based on spatial analysis of skin pixels, however this direction has been little explored so far. Our contribution lies in using the distance transform for propagating the "skinness" across the image in a combined domain of luminance, hue and skin probability. In the paper we explain theoretical advantages of the proposed**

likelihood that a pixel belongs to a skin region) from skin seeds to determine the boundaries of skin regions. The propagation is based on the distance transform, whose weights are obtained using both the probability map and color image. Using such a combined domain the stability of our detector is increased, whereas cumulative character of the distance transform allows for detecting skin boundaries even if they are smooth in the propagation domain. This is an important advantage over alternative region growing approaches, which was clearly manifested in the obtained experimental results.

The paper is organized as follows. Existing methods are

(a)

(b)

(c)

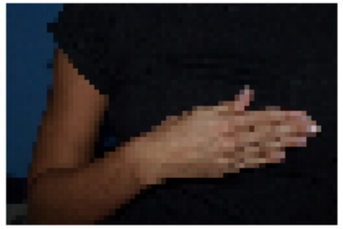
(d)

optimized implementation :)

```python
def dif_max_min(element):
    return np.max(element) - np.min(element)

def _get_fea_vec(img):
    vec = [img]
    for s in [5,9,13]:
        vec.append(generic_filter(img, np.median, size=s))
        vec.append(generic_filter(img, np.min, size=s))
        vec.append(generic_filter(img, np.std, size=s))
        vec.append(generic_filter(img, dif_max_min, size=s))
    return np.stack(vec)

def _get_fea_vec_multi(imgs,cores,index,res = {}):
    for i in range(len(imgs)):
        if i%cores != index:
            continue
        res[i] = _get_fea_vec(imgs[i])
        #print(i)



def get_fetures_vector(imgs):
    results = {-1:-1}
    Ts = []
    for i in range(20):
        t = threading.Thread(target=_get_fea_vec_multi,args=(imgs,20,i,results))
        Ts.append(t)
    for t in Ts :
        t.start()
    for t in Ts:
        t.join()


    del results[-1]
    return list(dict(OrderedDict(sorted(results.items()))).values())

hgr_feature_vectors = get_fetures_vector(hgr_prob_maps)
hgr_feature_vectors_lum = get_fetures_vector(hgr_lum_maps.copy())
```

Procedure outputs

Input Image(DSPF procedure)



Mask of image

Prob. map

Median with Kernel 5*5

Min with Kernel 5*5

STD with Kernel 5*5

MAX-MIN with Kernel 5*5

Median with Kernel 9*9

Min with Kernel 9*9

STD with Kernel 9*9

MAX-MIN with Kernel 9*9

Median with Kernel 13*13

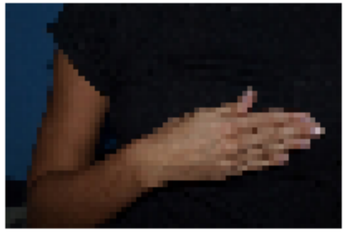
Min with Kernel 13*13

STD with Kernel 13*13

MAX-MIN with Kernel 13*13

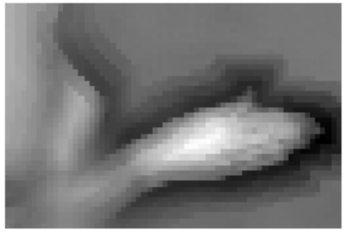
Procedure outputs

Input Image(DSPF-L procedure)

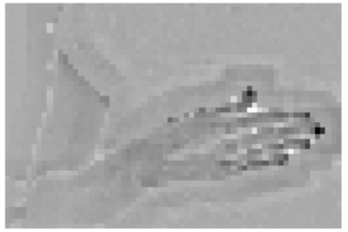


Mask of image

DSPS #1 dim

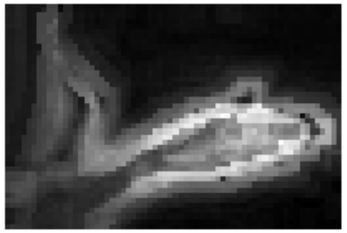


DSPS #2 dim



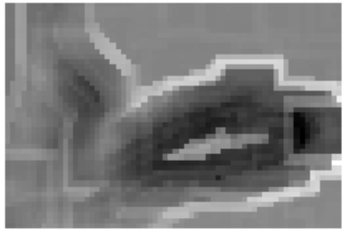
DSPS #3 dim

DSPS #4 dim

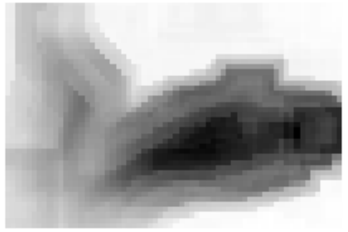


DSPS #5 dim

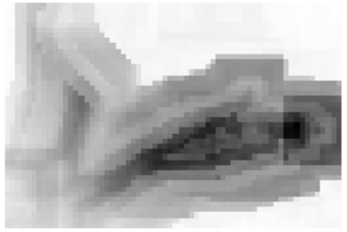
DSPS #6 dim



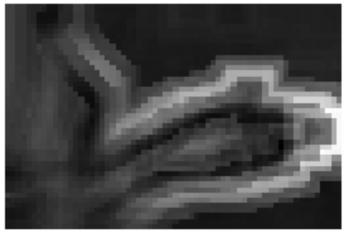
DSPS #7 dim



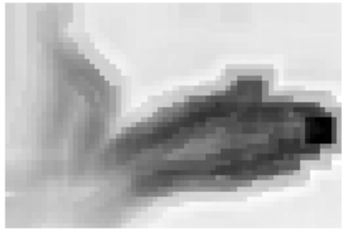
DSPS #8 dim



DSPS #9 dim

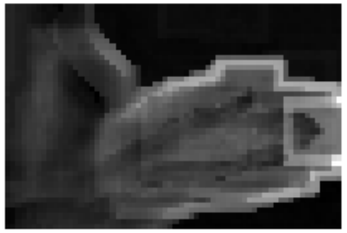


DSPS #10 dim

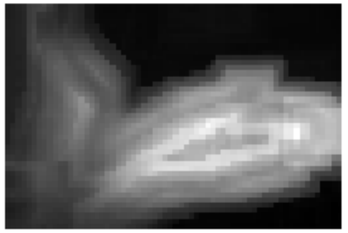


DSPS #11 dim

DSPS #12 dim



DSPS #13 dim

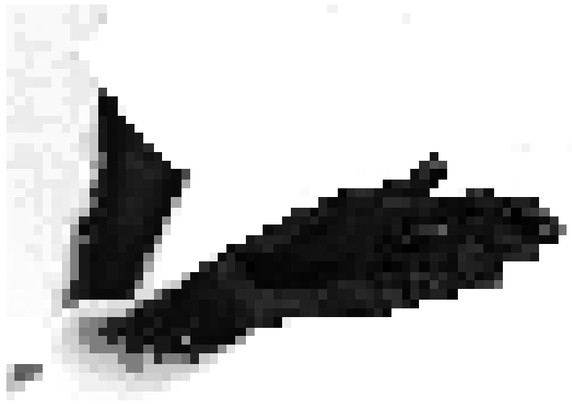


Procedure outputs

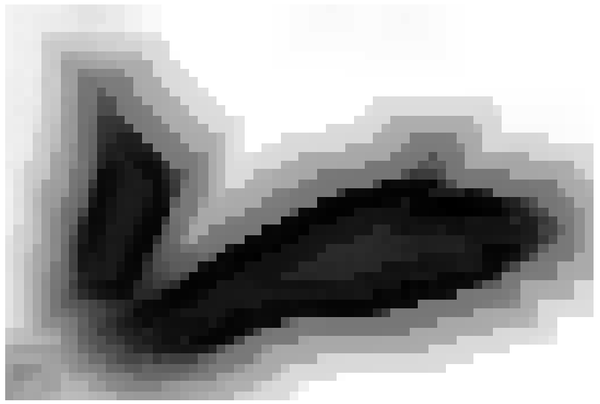
Orginal image

True mask

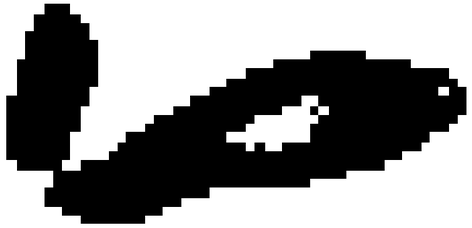
Prob. map



DSPF skin map



Extracted seeds



Skin map after spatial analysis using distance transform

predicted mask

Masked image

Thank you for spending time!

Mohsen Ebadpour
M.Ebadpour@aut.ac.ir