
OPTIMAL GABOR FILTER BANK SELECTION FOR FACE FEATURES LOCALIZATION

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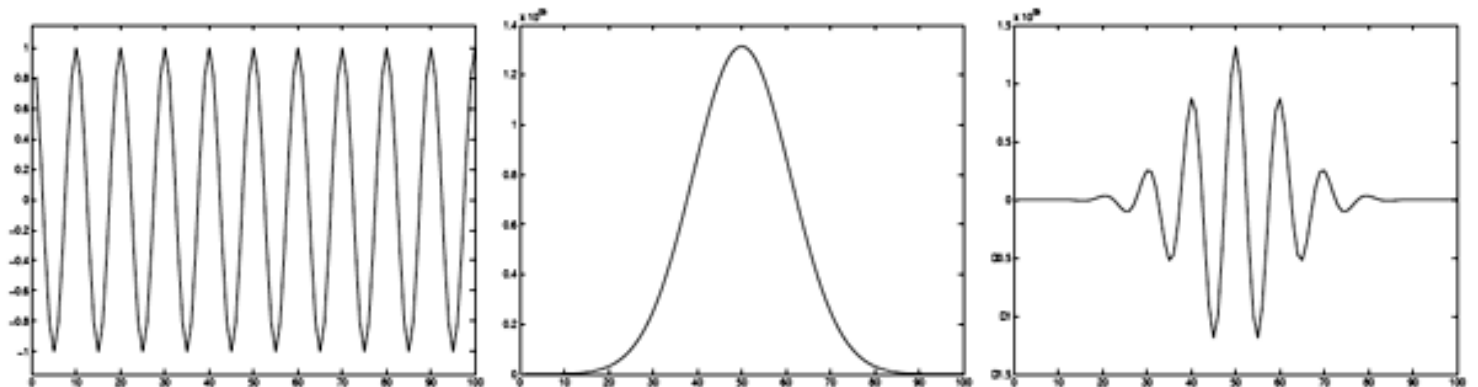


AGENDA

- Introduction
- Gabor filters
- Face features localization
- Optimal filter bank selection
- Conclusion

INTRODUCTION

- Face features detection/localization using Gabor filters
 - Rediscovery of Gabor Filters on 21st century
 - Application along with machine learning techniques
 - Computational cost of Gabor Filter based methods
 - 1D Gabor function:



GABOR FILTERS

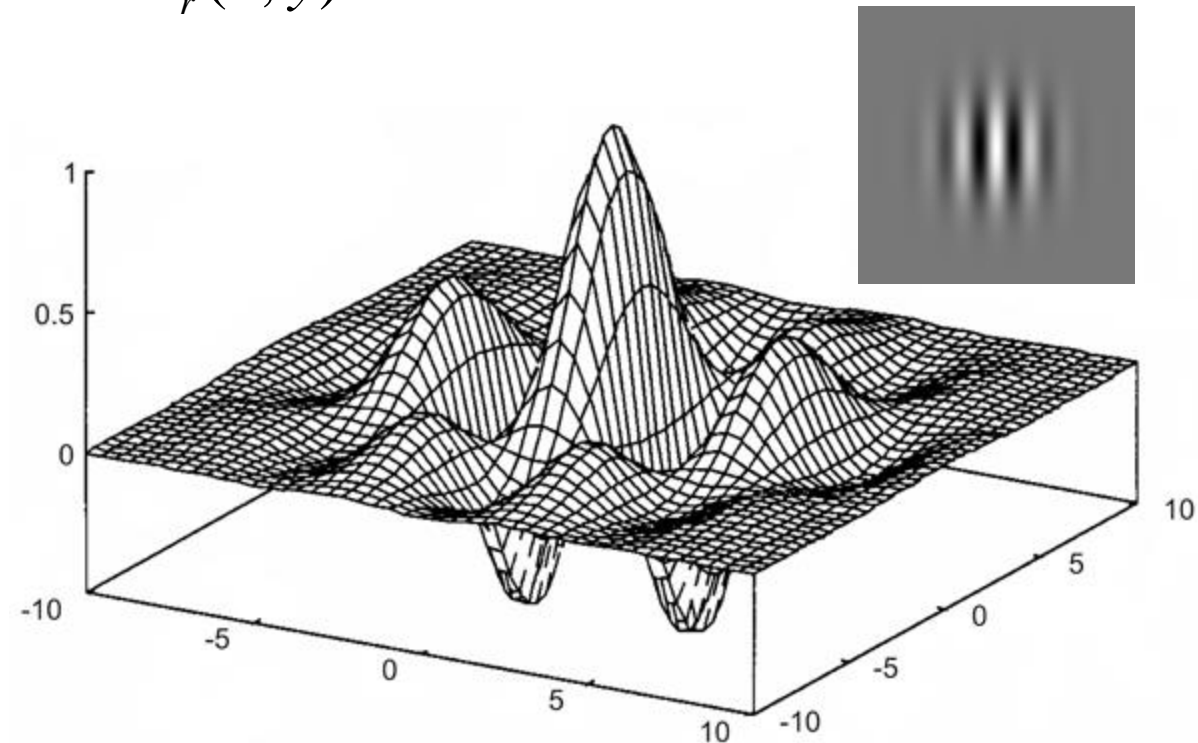
- 2-D Gabor filters are formed as a sinusoidal plane wave modulated by 2-D Gaussian function

$$g(x, y) = s(x, y) \cdot w_r(x, y)$$

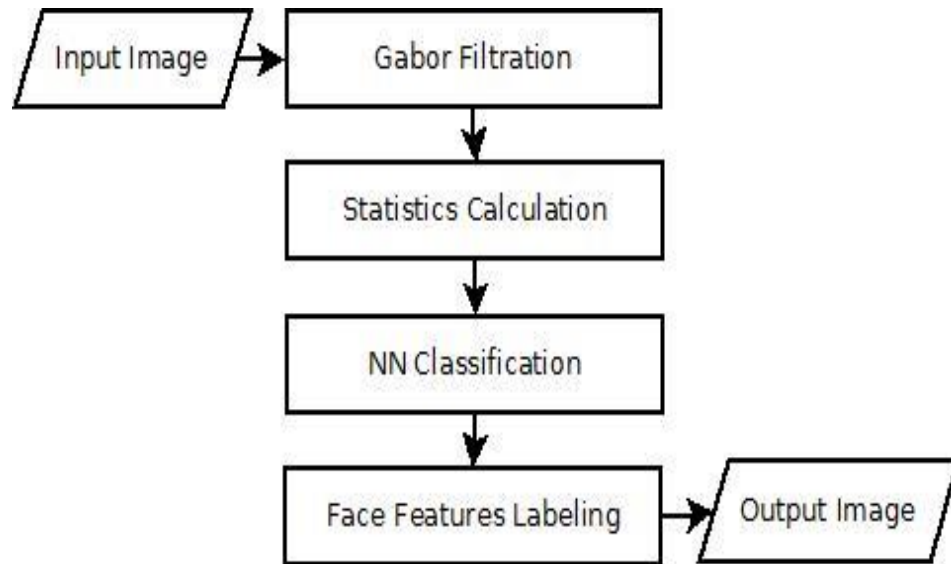
$$s(x, y) = e^{j2\pi(u_0x + v_0y) + P}$$

$$w_r(x, y) = K \cdot e^{-\pi(a^2(x-x_0)^2 + b^2(y-y_0)^2)}$$

- K scales the magnitude of the Gaussian envelope
- a, b scale axes of the Gaussian envelope
- (x_0, y_0) determines coordinates of the envelope maximum
- P is the phase of the sinusoidal wave



FACE FEATURES LOCALIZATION

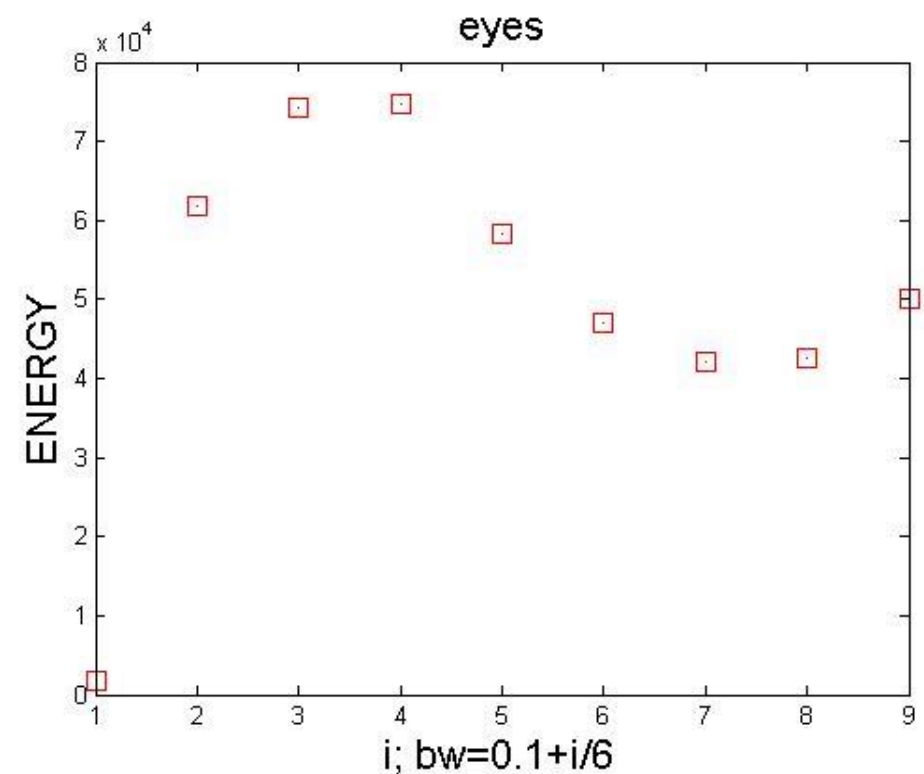


- Face region is being screened using floating window technique
- Gabor filtration – usually large filter bank is used (approx. 40 filters). Our goal is to reduce its size thus still get satisfactory results.
- Statistics measure different properties of the textures. Eight statistics – Standard deviation, energy, median, upper quantile, lower quantile.
- For classification, multi-layer perceptron is used with two hidden layers

OPTIMAL FILTER BANK SELECTION

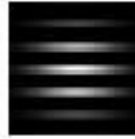
- Optimal bank is selected by reducing large filter bank containing 72 filters
- Filters are selected based on statistical values of the filter response for the particular face features
- Energy and standard deviation is used for the filter inspection
- Filter bank containing 8 filters is selected. Filters are selected from the optimum point neighbourhood in the 3D graph depicting dependency of energy, standard deviation and bandwidth of the filter responses.

- Energy plot for $\theta = 0$ rad. Filters for eye detection

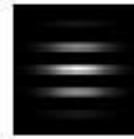


OPTIMAL GABOR FILTER BANK

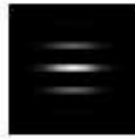
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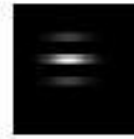
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bw=0.76667 theta=0



bw=0.93333 theta=0



bw=1.6 theta=-1.5708



bw=1.4333 theta=-1.5708



bw=1.4333 theta=1.5708



bw=1.6 theta=1.5708



CONCLUSION

- Validation of results is achieved by comparison of two banks used in the same face features localization algorithm
- Filter bank 1 was selected as an optimal filter bank based on described approach - contains 8 filters
- Filter bank 2 was presented by authors Mao, Zhang and Chai and - contains 40 filters

Face feature	Filter bank 1		Filter bank 2	
	Correct det.	FP	Correct det.	FP
Eyes	86	11	83	15
Mouth	89	11	80	18
Nose	95	4	86	10

- Optimal bank declares better results in both correct detections and false positives count
- Localization of the nose is successful in much more cases than of the other features. It is probably caused by the larger dimensions of nose region compared to other face features