



Faculty of Science



# A study of higher order image descriptors

## Thesis defence

Benjamin Braithwaite

Malte Nissen

Department of Computer Science



# Agenda

① Introduction to image descriptors

② Image correspondence

③ Pedestrian detection



# Agenda

① Introduction to image descriptors

② Image correspondence

③ Pedestrian detection



# Image transformations



# Scale-space



# Applications



(a) Image correspondence



(b) Pedestrian detection



# Agenda

① Introduction to image descriptors

② Image correspondence

③ Pedestrian detection



# Interest point detection



# Matching strategy



# Proposed descriptor

$$H_j(f_i) = \int F(\mathbf{x}) A_j(\mathbf{x}) P(\mathbf{x}) B(\mathbf{x}; f_i, f) d\mathbf{x}$$

where

$i$  is the bin number

$j$  is the cell number



# Histogram domain

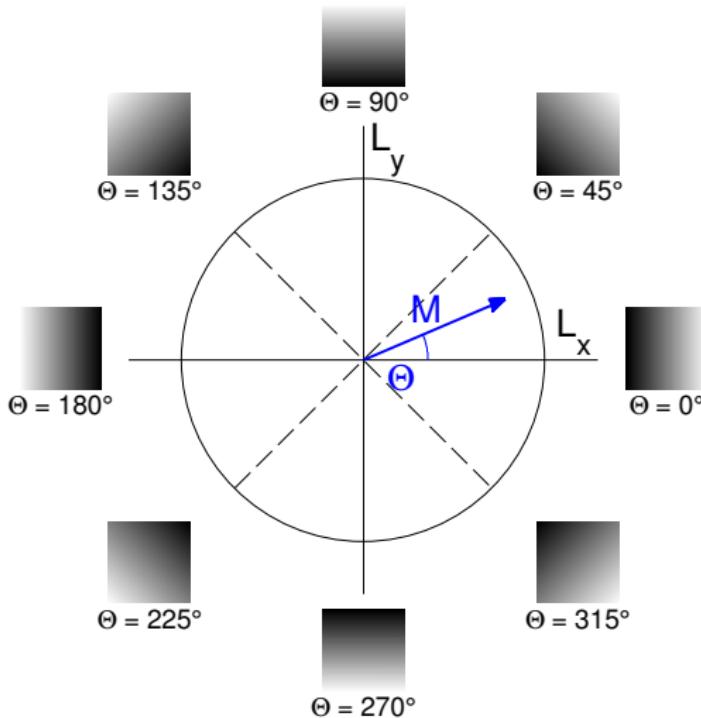
$$H_j(f_i) = \int F(\mathbf{x}) A_j(\mathbf{x}) P(\mathbf{x}) B(\mathbf{x}; f_i, f) d\mathbf{x}$$

Bin value function  $f$

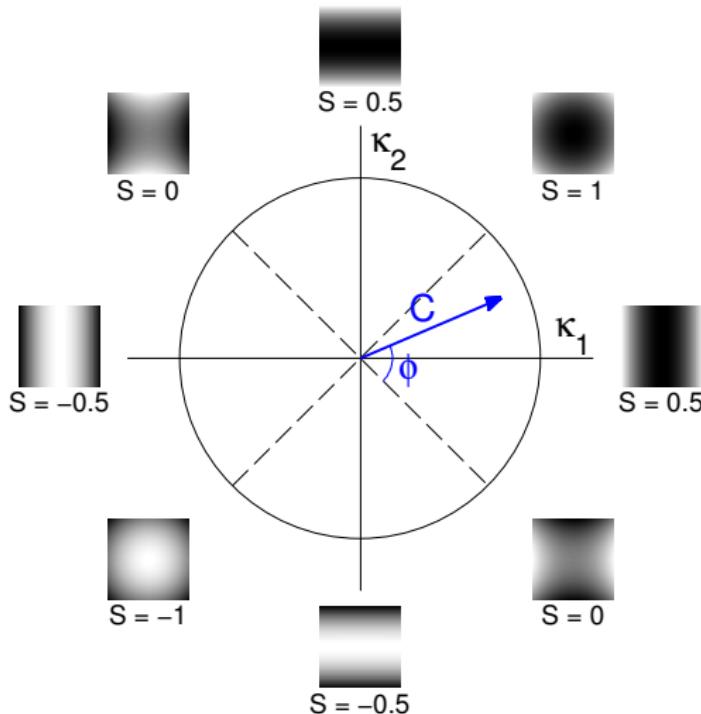
Magnitude function  $F$



# Gradient orientation



# Shape index



# Local magnitude normalization



# Spatial weights

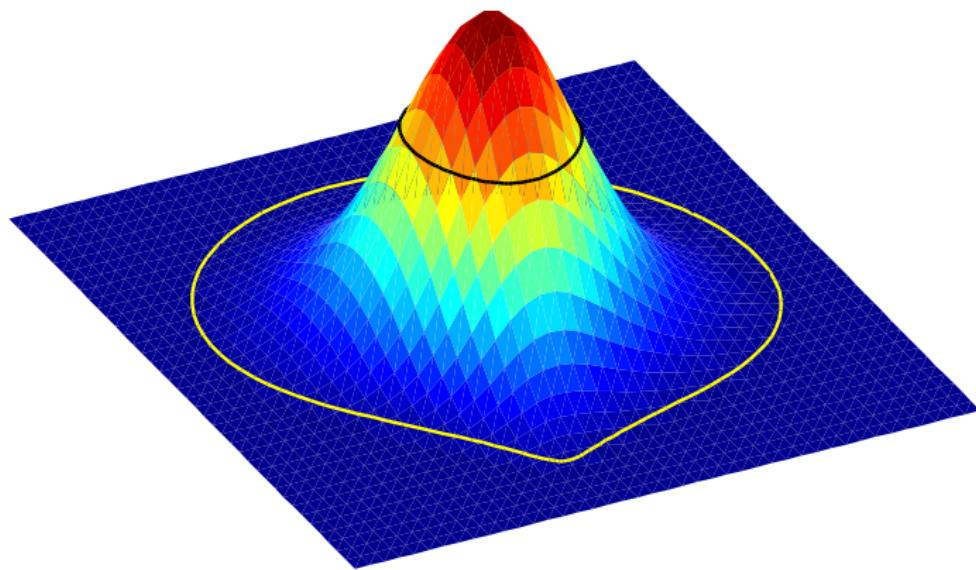
$$H_j(f_i) = \int F(\mathbf{x}) A_j(\mathbf{x}) P(\mathbf{x}) B(\mathbf{x}; f_i, f) d\mathbf{x}$$

Cell aperture function  $A$

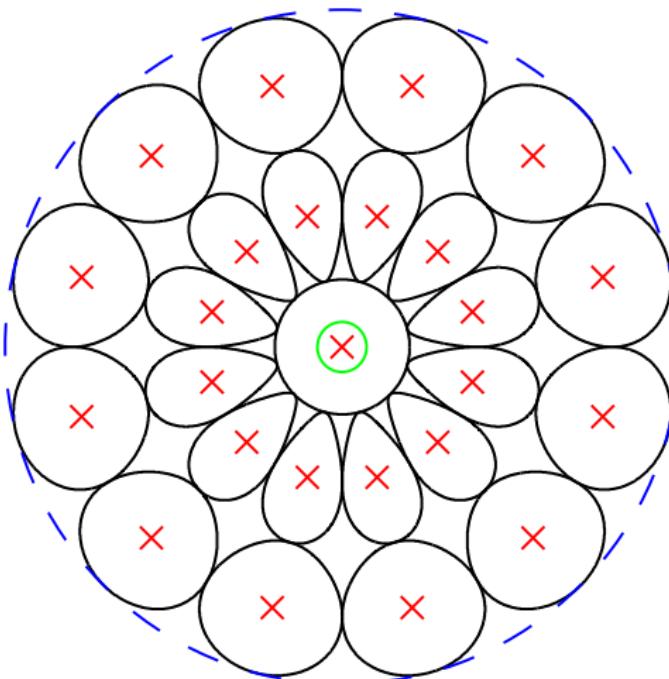
Center aperture function  $P$



# Cell aperture function



# Grid of cells



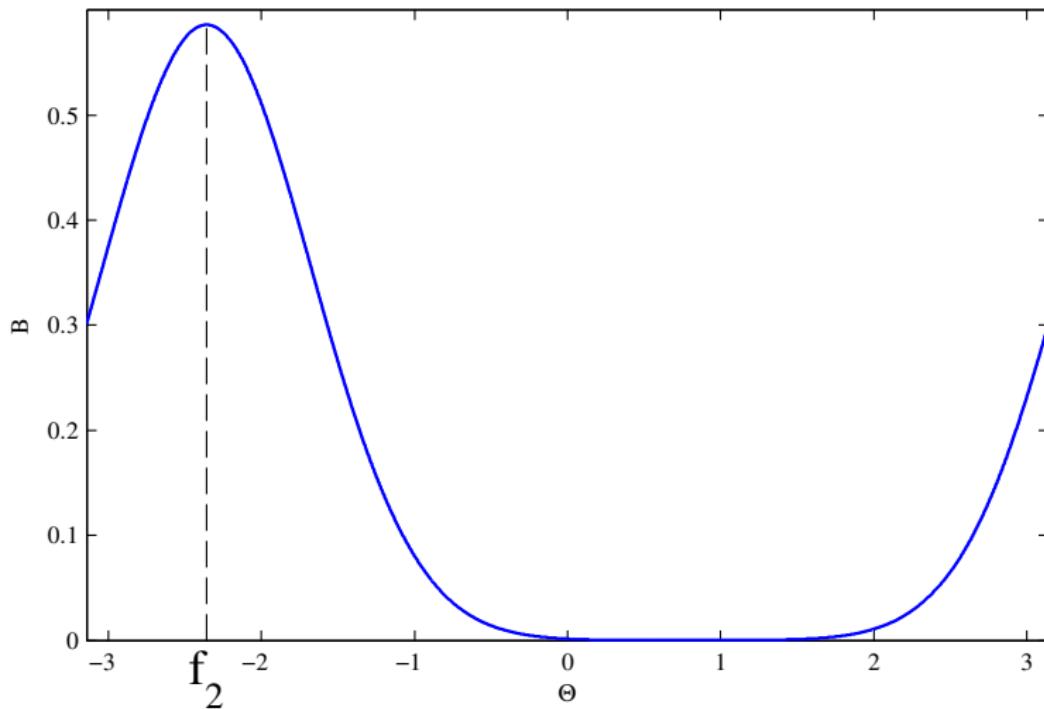
# Bin weights

$$H_j(f_i) = \int F(\mathbf{x}) A_j(\mathbf{x}) P(\mathbf{x}) B(\mathbf{x}; f_i, f) d\mathbf{x}$$

Bin aperture function  $B$

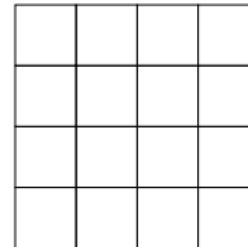


# Bin weights



# SIFT [2]

- $4 \times 4$  square grid
- Trilinear interpolation
- Clipping of magnitudes
- Include comparison results?



# Agenda

① Introduction to image descriptors

② Image correspondence

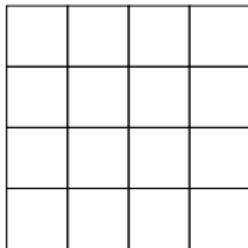
③ Pedestrian detection



# Sliding window



# HOG [1]



# References

- [1] Navneet Dalal and Bill Triggs. "Histograms of oriented gradients for human detection". In: *Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on.* Vol. 1. IEEE. 2005, pp. 886–893.
- [2] David G Lowe. "Distinctive image features from scale-invariant keypoints". In: *International journal of computer vision* 60.2 (2004), pp. 91–110.

