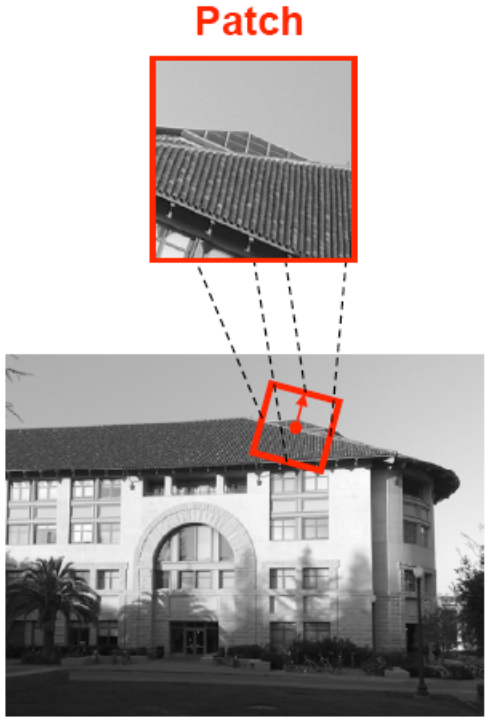
# Histogram of Oriented Gradients

Grace Tsai
Electrical Engineering, Systems
University of Michigan
September 28, 2010

How can we find a good representation for all these people?




How can we find a good representation for an interested point?

# Introduction

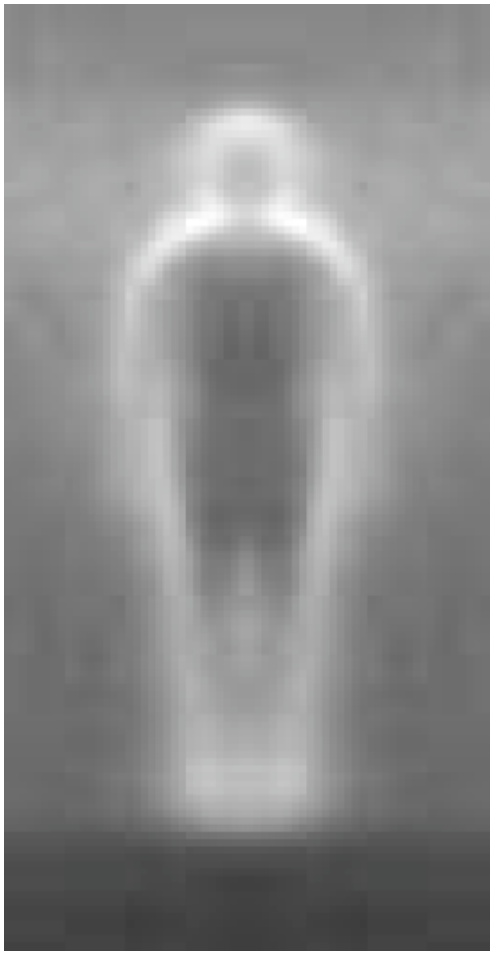
- Find robust feature set that allows object form to be discriminated.
- Challenges
  - Wide range of pose and large variations in appearances
  - Cluttered backgrounds under different illumination
  - “Speed” for mobile vision
- Reference

[1] N. Dalal and B. Triggs. Histograms of Oriented Gradients for Human Detection. In CVPR, pages 886-893, 2005

[2] Chandrasekhar et al. CHoG: Compressed Histogram of Gradients - A low bit rate feature descriptor, CVPR 2009

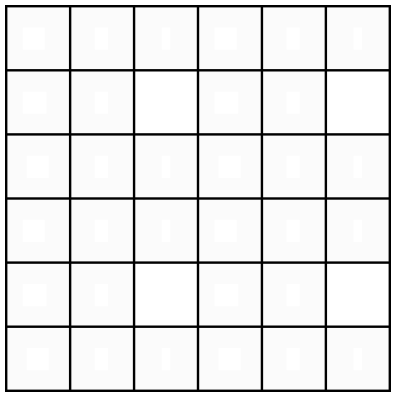
# Why HoG?

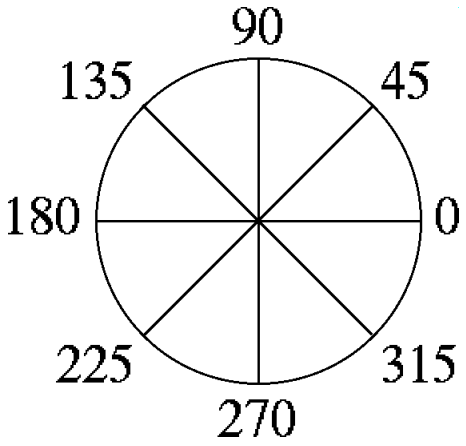
- Local object appearance and shape can often be characterized rather well by the distribution of local intensity gradients or edge directions.



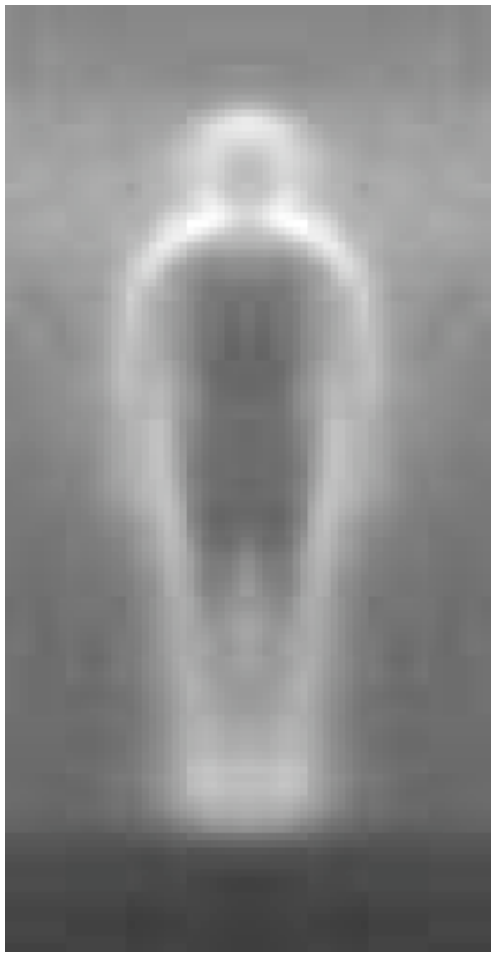
# Histogram of Gradient

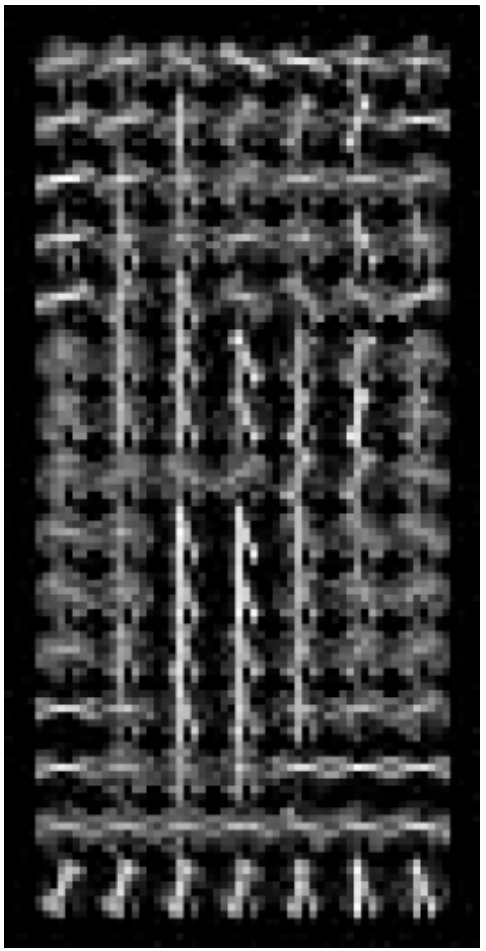
- Dividing the image window into small spatial regions (*cells*)
- Cells can be either rectangle or radial.
- Each cell accumulating a weighted local 1-D histogram of gradient directions over the pixels of the cell.





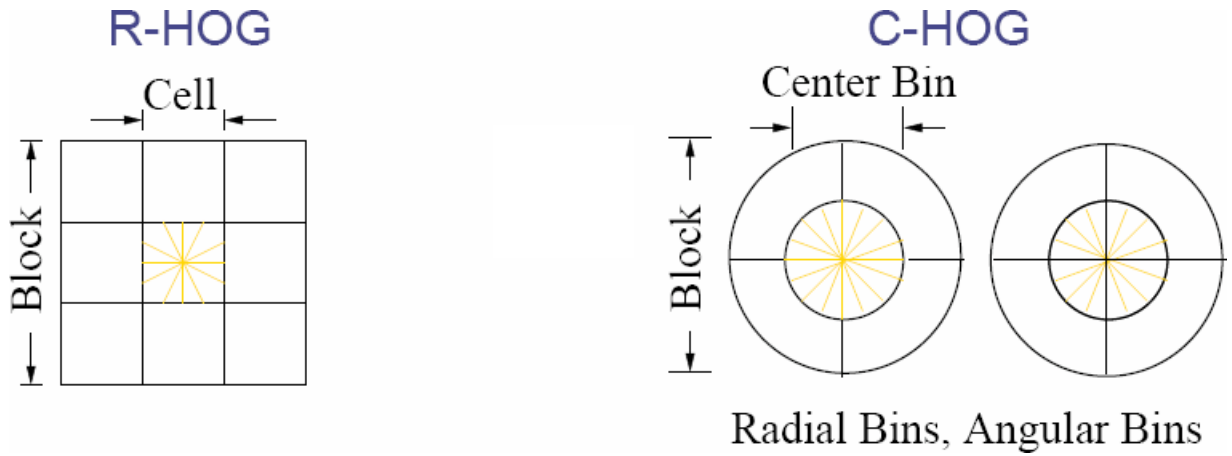
# Histogram of gradient





# Normalization

- For better invariance to illumination and shadowing. it is useful to contrast-normalize the local responses before using them.
- Accumulate local histogram “energy” over a larger regions (“blocks”) to normalize all of the cells in the block.

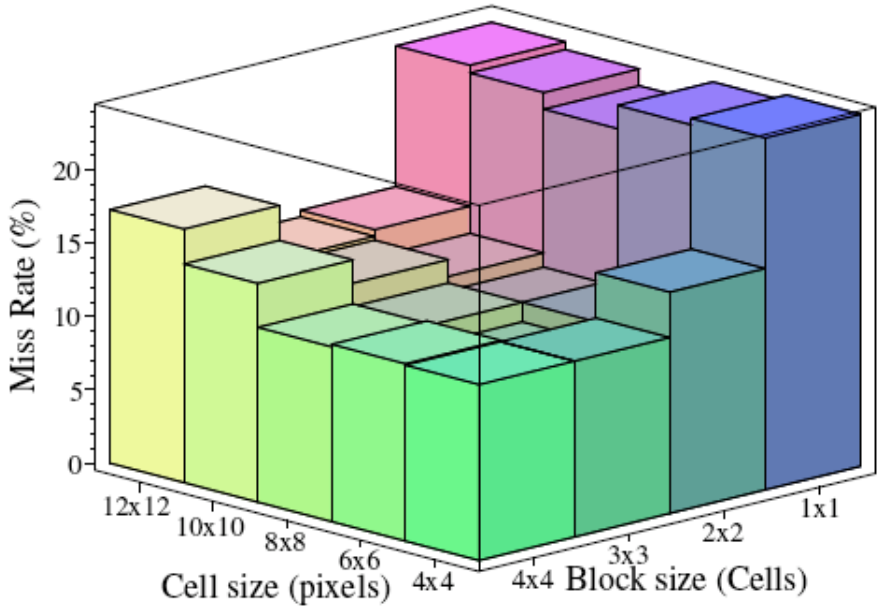


# Implementation

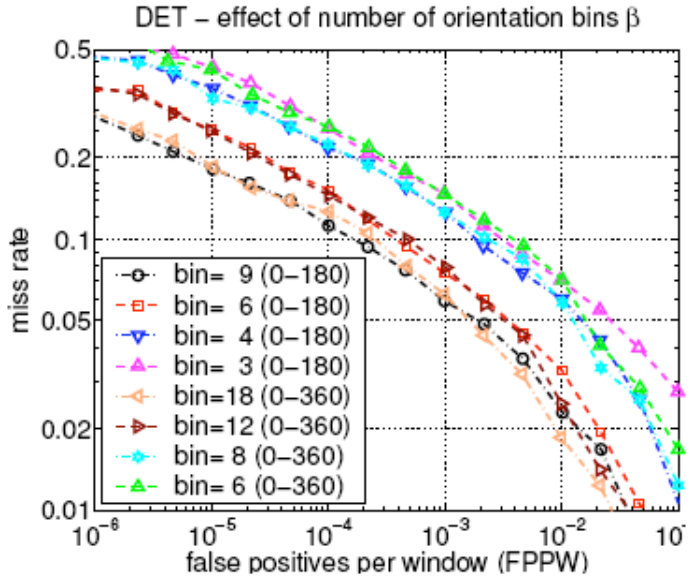

- 64*128 detection window
- Normalize gamma and color by RGB and LAB to normalize the energy of the cells.
- Linear SVM for object/non-object classifications.

[1] N. Dalal and B. Triggs. Histograms of Oriented Gradients for Human Detection. In CVPR, pages 886-893, 2005

# Comparisons



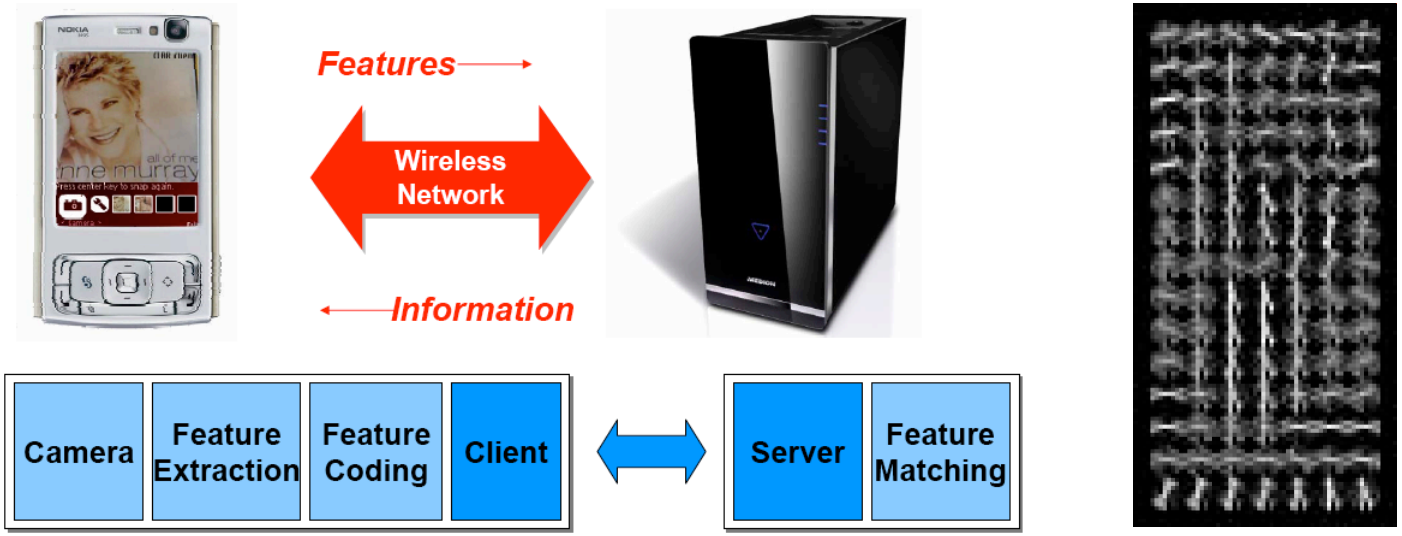

Miss rate as the cell and block size changes.




Effect of number of orientation bins

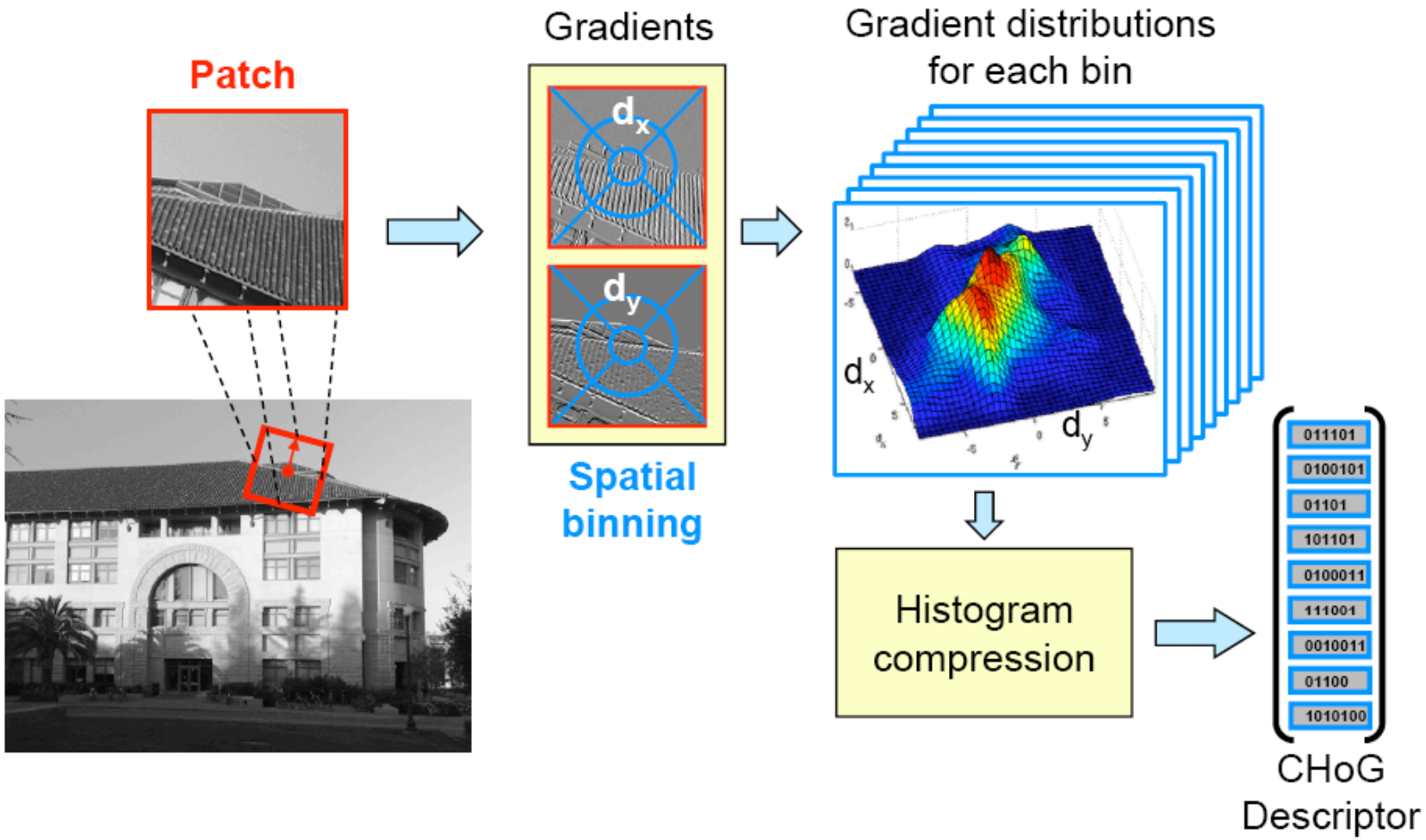
# Compressed Histogram of Gradients

- Feature compression is vital for reduction in storage, latency and transmission.

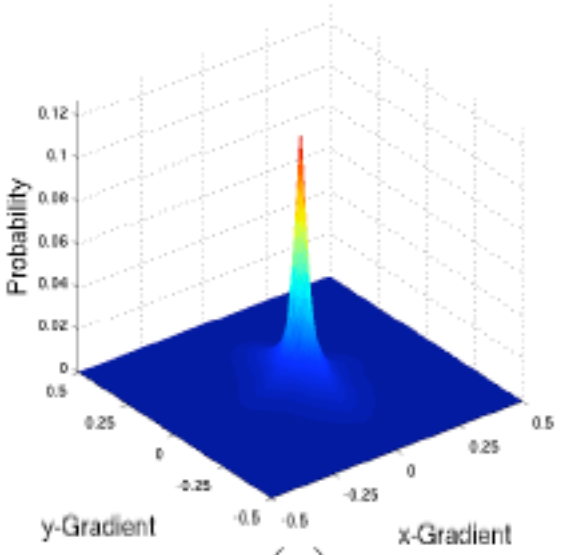



[2] Chandrasekhar et al. CHoG: Compressed Histogram of Gradients - A low bit rate feature descriptor, CVPR 2009

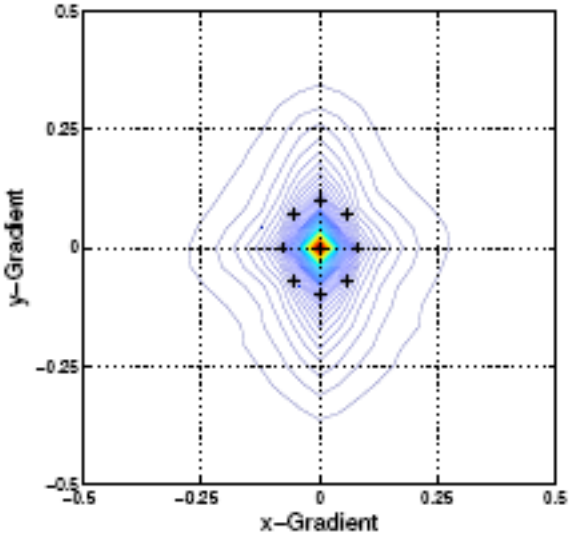
# Compressed HoG



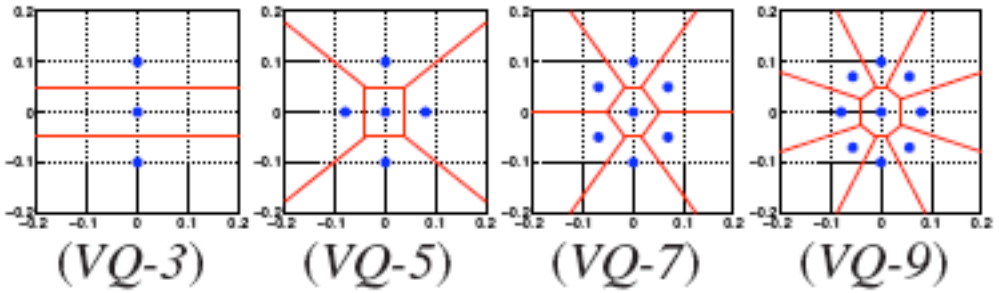
# Gradient Histogram Binning




(a)

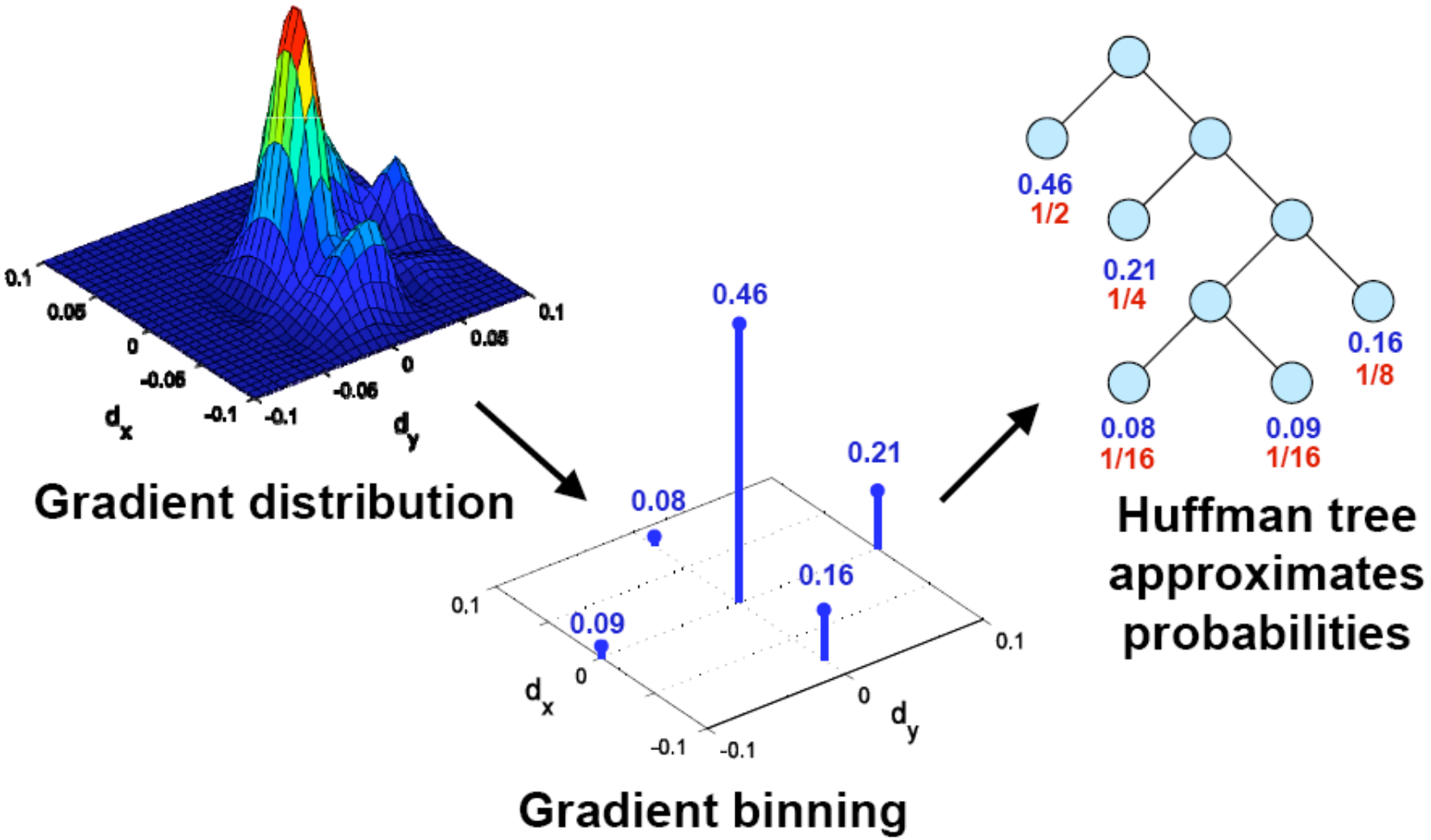



(b)

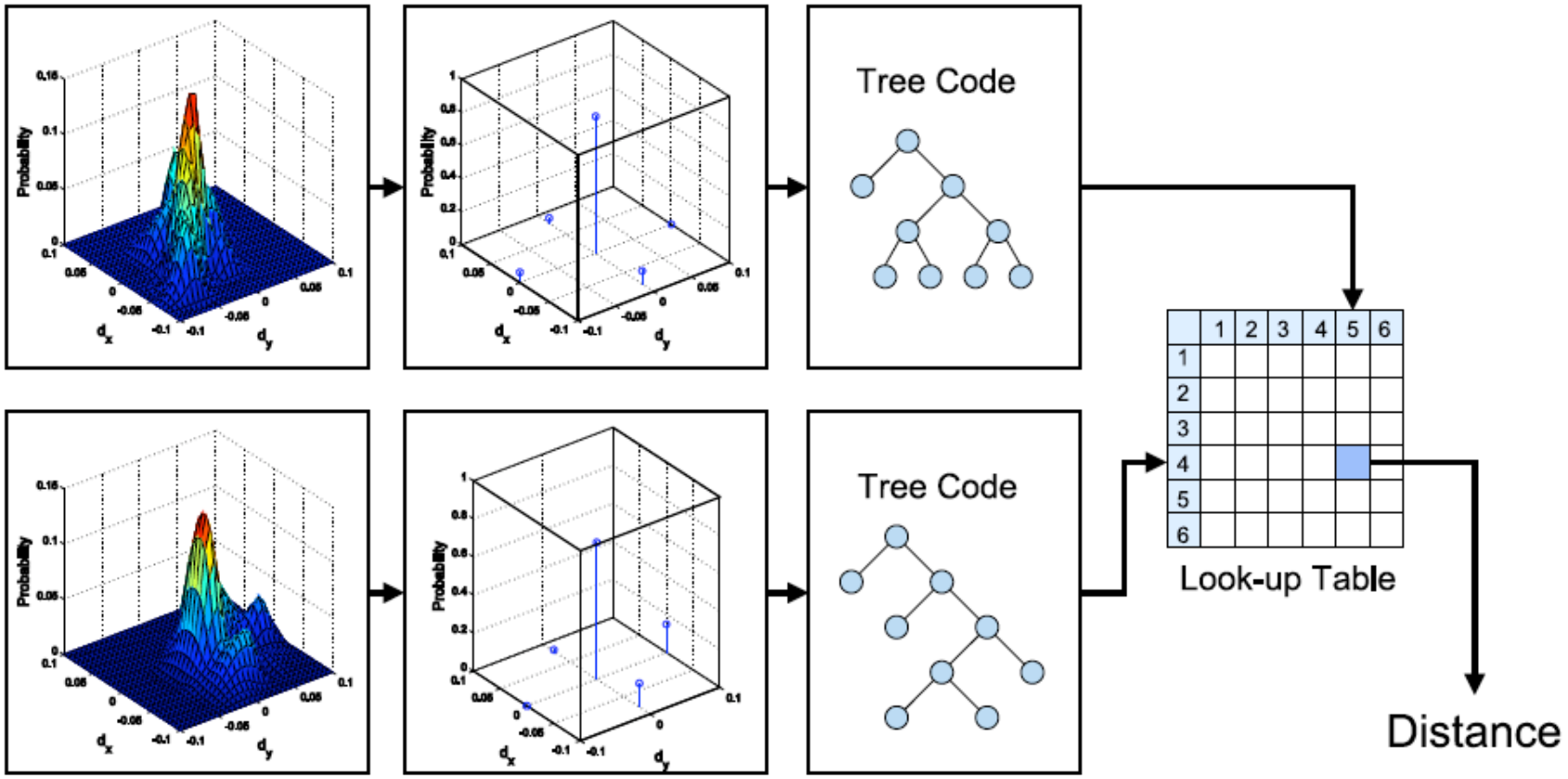


(VQ-3) (VQ-5) (VQ-7) (VQ-9)

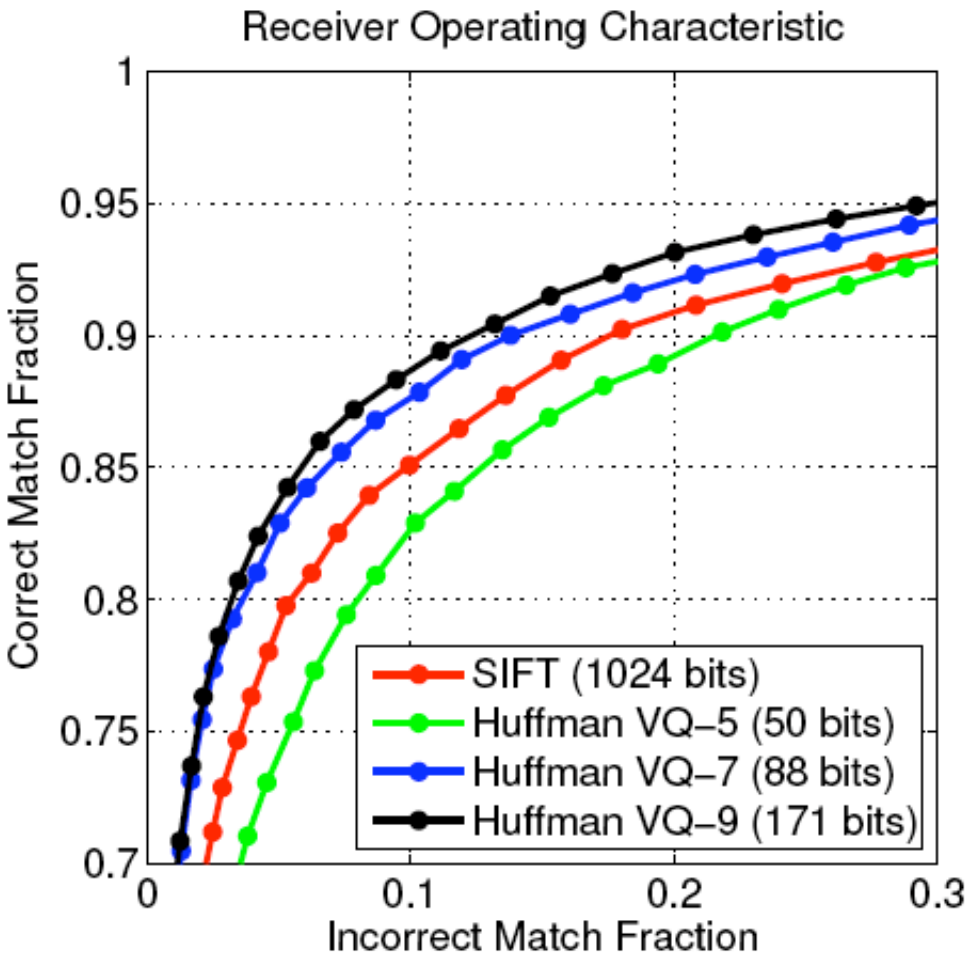
# CHoG: Huffman coding



# Search Strategies



# Comparisons



# Applications

- http://www.youtube.com/watch?v=1-rwzgUlyzw&feature=player_embedded
- http://www.youtube.com/watch?v=0HOO80RitVI&feature=player_embedded
- http://www.stanford.edu/~vijayc/publication.html

# Reference


[1] N. Dalal and B. Triggs. Histograms of Oriented Gradients for Human Detection. In CVPR, pages 886-893, 2005

[2] Chandrasekhar et al. CHoG: Compressed Histogram of Gradients - A low bit rate feature descriptor, CVPR 2009

[3] V. Chandrasekhar et al. "Quantization Schemes for the Compressed Histogram of Gradients descriptor," *Proceedings of International Workshop on Mobile Vision, Computer Vision and Pattern Recognition (CVPR),* San Francisco, June 2010.

[4] http://www.stanford.edu/~vijayc/publication.html

[5] www.stanford.edu/~dmchen/documents/IWMV2010_CHOG_slides.pdf

[6] http://www-forum.stanford.edu/events/2010slides/cleanslatePOMI/POMI2010Girod.pdf