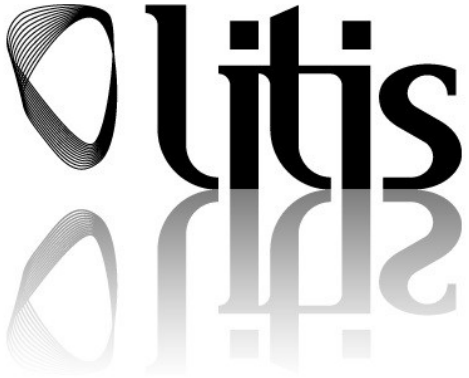
A pedestrian detector using Histograms of Oriented Gradients and a Support Vector Machine Classifier

M. Bertozzi, A. Broggi, M. Del Rose,

M. Felisa, A. Rakotomamonjy, F Suard



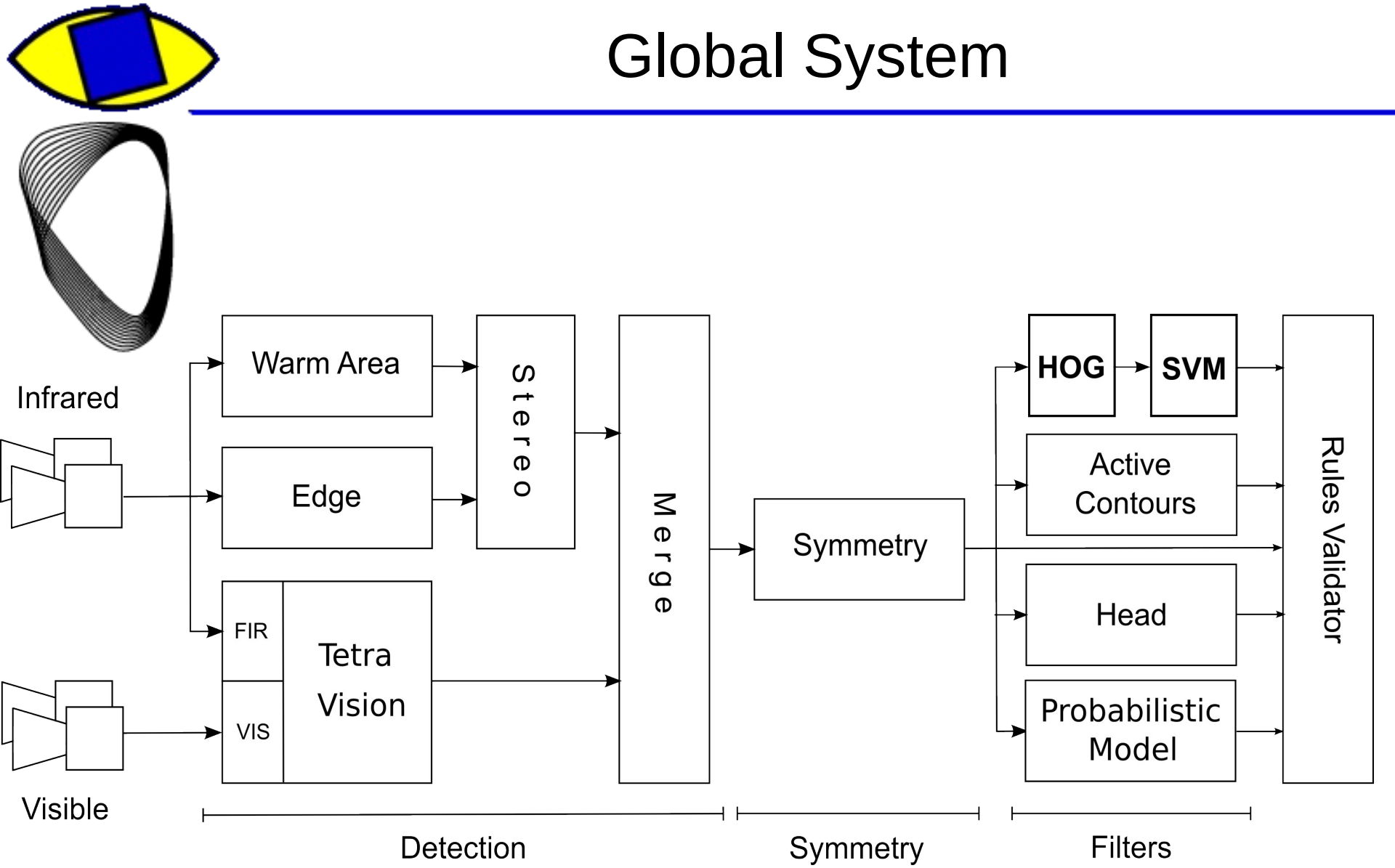
ITSC 2007, SEATTLE, 1st October 2007

Introduction

- Pedestrian detection
  - Variability issues : pose, scale, appareance
  - Driver assistance

- Recognition system :
  - Tetravision : infrared and visible
  - Subsystem : bounding box characterization and validation.

Global System



Process

1. Acquisition Extract areas of interest and define bounding boxes for each obstacle,
2. Filter bounding boxes to reject non-pedestrians,
3. Validate candidates with HoG descriptor and SVM classifier.

Acquisition

- Tetravision :
  - Infrared stereovision cameras

  - Visible stereovision cameras

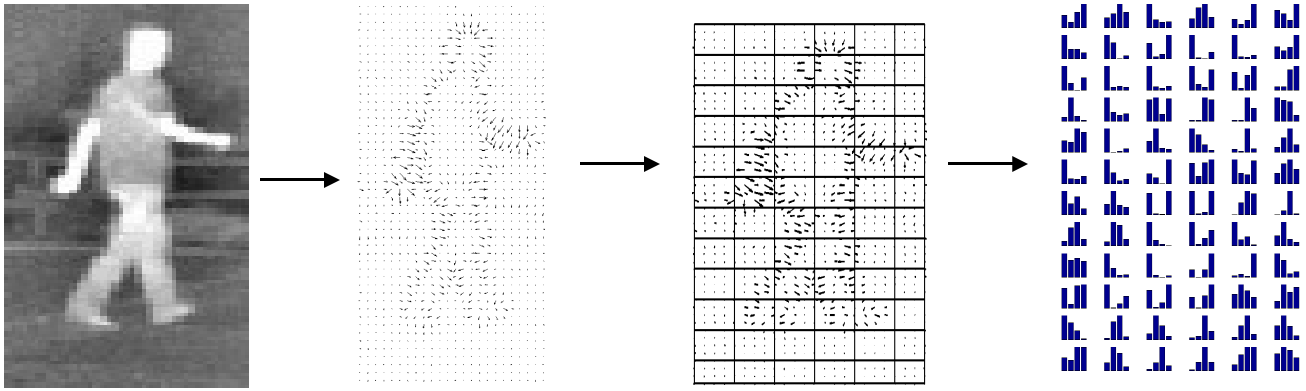
- Complementarity of information and limitations
- Stereovision → areas of interest

Analysis

- Bounding box filtering :
  use symmetry, size and edge density information
- Validation :
  characterize shape information using Histograms of Oriented Gradients and classifies with SVM

Analysis

- Histograms of Oriented Gradient :
  - Shape information
  - Computation of histograms of gradient orientation with regards of a dense image cutting.



- SVM
  - Binary classifier
  - K : Linear kernel,

$$f(x) = \sum_i w_i . K(x, x_i) + b$$

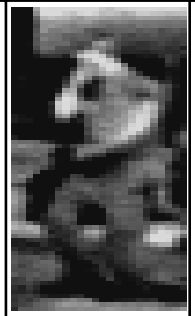
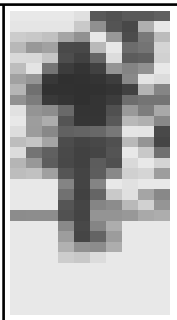
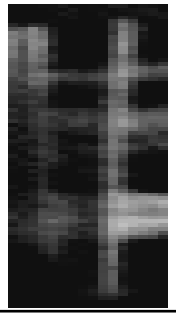
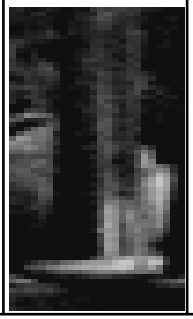
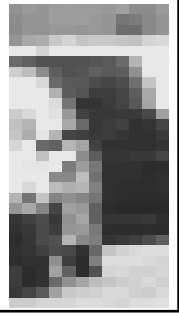
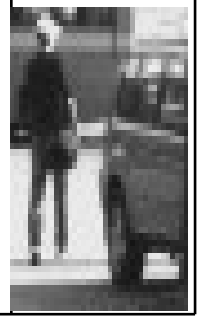
Results

- 2 video sequences :
  - Night and day,
  - Both infrared and visible.
- Bounding boxes extracted and filtered:

	Day		Night	
	FIR	VIS	FIR	VIS
pedestrian	2255	1860	1678	1359
nonpedestrian	20246	20520	2933	3262

Results :

- Manual label of all images to improve the method.
- Examples of pedestrians and non-pedestrians bounding boxes (128*64 pixels):

	Infrared			Visible		
Pedestrian						
Non-pedestrian						

Results - 2

- Evalution of HoG and SVM recognition stage :
  - Generalization capacity (size of learning set varies),
  - day/night, FIR/VIS performance.
- Tuning stage : optimal parameters for HoG and SVM
- Plot number of false positive against true positive and compute Area under Curve :

		10	50	100	500
Night	FIR	0.9554	0.9602	0.9662	0.9704
	VIS	0.9364	0.9447	0.9523	0.9550
Day	FIR	0.7304	0.8374	0.8622	0.8935
	VIS	0.7416	0.8460	0.8618	0.8977

- Recognition rate (%) :

		10	50	100	500
Night	FIR	0.9554	0.9602	0.9662	0.9704
	VIS	0.9364	0.9447	0.9523	0.9550
Day	FIR	0.7304	0.8374	0.8622	0.8935
	VIS	0.7416	0.8460	0.8618	0.8977

Conclusion and perspectives

- Pedestrian detection system : bounding box validation,
- Filtering, Hog descriptor and SVM classifier,
- Promising results,
- Improvements :
  - Add other characterizations and filters,
  - reduce computation time.