Path Detection in Video Surveillance

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Objective

- Automatically extract frequently used pedestrian pathways from video sequences.

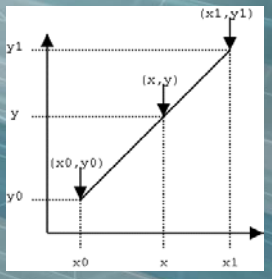
Motivation

- Identifying different paths
- Logging of movement patterns
- Tracking

Definitions

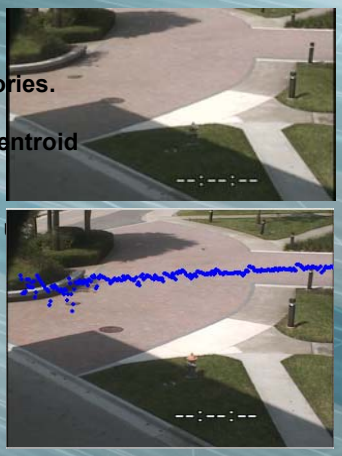
- Route
- Linear Interpolation

$$y = y_1 + \frac{(y_2 - y_1)}{(x_2 - x_1)} * (x - x_1)$$



Scene Model

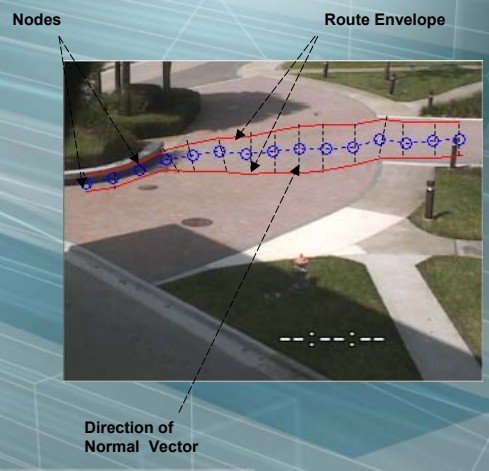
- Database for all trajectories.
- Trajectory derived by centroid of tracking object.
- Trajectories resampled Linear Interpolation.
- Routes learned from trajectories.



Scene Model

Node represented by

- 2D Image coordinates: $x_i = [x_i, y_i]$
- Weight factor w_i
- Normal Vector
- Boundary of distributions



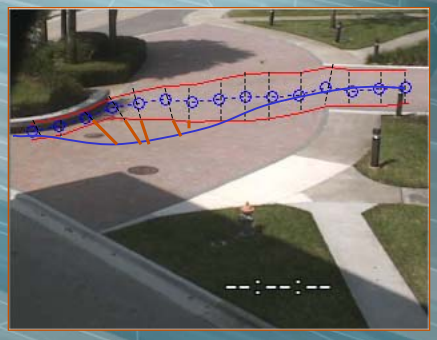
Route-Trajectory Match

•Each Trajectory compared to existing routes.

•Maximum separation distance between the trajectory and the route envelope calculated.

•Trajectory matched with minimum corresponding route.

•Weights of matched trajectory incremented.



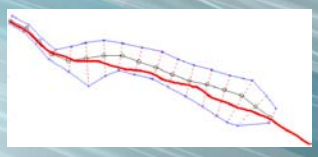
$$\vec{x}' = \frac{w}{w+1} * \vec{x} + \frac{1}{w+1} * \vec{x}^{\,t}$$

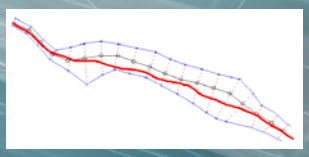
Route Updating

- Node Updating

$$\vec{x}' = \frac{w}{w+1} * \vec{x} + \frac{1}{w+1} * \vec{x}^{\,t}$$

- Route Extension





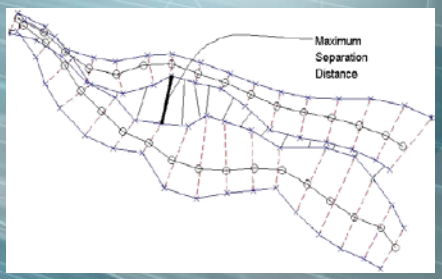
- Route Resampling

Route Merging

•Close routes are merged.

•Node of the main route compared with the virtual node of the secondary route.

•Envelope of merged route formed by combination of two routes.



$$\vec{x}' = \frac{w_1 * \vec{x} + w_2 * \vec{x}_t}{w_1 + w_2}$$

$$w'_1 = w_1 + w_2$$

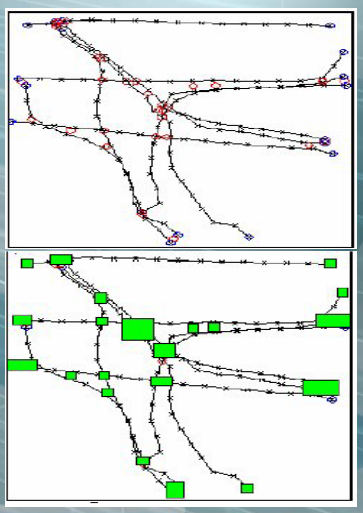
Semantic Description

Common sections of routes are grouped and junctions created.

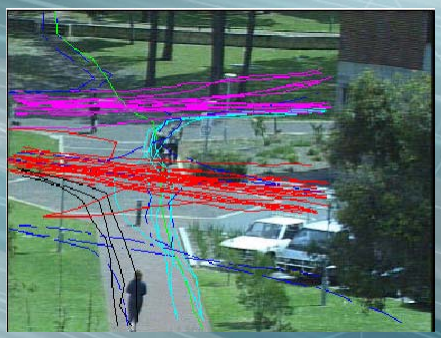
Constructing paths

- entry/exit zones
- Junctions

$$P_{ij} = \frac{N_{ij}}{\sum_k N_{ik}}$$



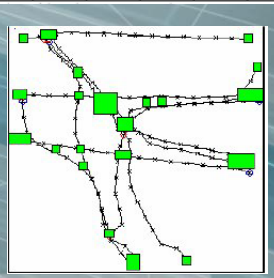
Results



Results

Entry node	Exit node probability									
	1	2	3	4	5	6	7	8	9	10
1			1.0							
2						0.17	0.58	0.25		
3	1.0									
4										1.0
5						0.27		0.73		
6		0.14			0.18				0.68	
7		1.0								
8		0.38			0.48					0.14
9						1.0				
10				0.89				0.11		

$$P_{ij} = \frac{N_{ij}}{\sum_{k} N_{ik}}$$

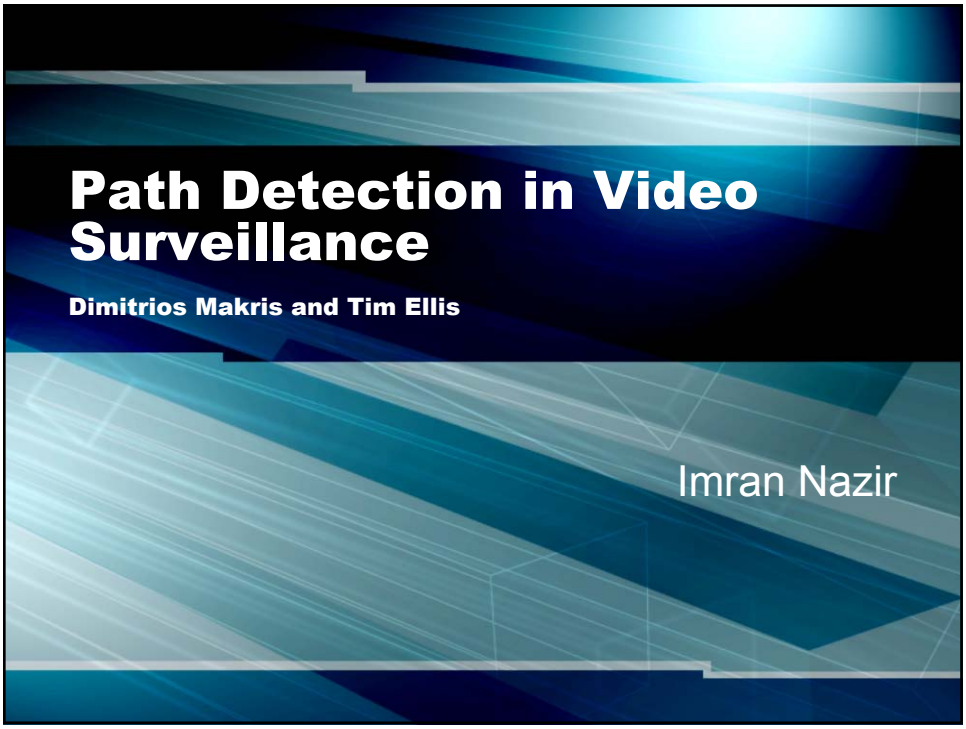


Problems

- Zigzag trajectories within the envelope not detected.
- Using only linear interpolation.
- System not using online tracking.
- Using centroid for detection.
- No temporal information.
- Updating route envelopes might end up making the whole scene a single route.

Improvements

- Fitting better model on trajectories.
- Using Hausdorff distance.
- logging of velocity magnitude.
- Extension to multiple cameras.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