Multiview Pedestrian Localisation via a Prime Candidate Chart Based on Occupancy Likelihoods

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INTRODUCTION

A sound way to localize occluded people is to project the foregrounds from multiple camera views to a reference view using homographies and finding the foreground intersections [1].

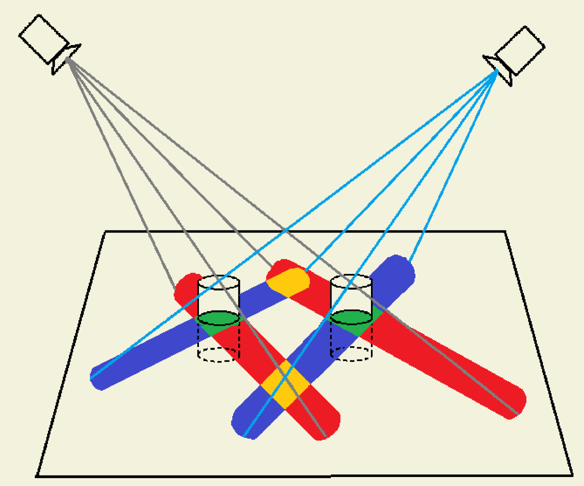


Fig.1 Phantom occurrence

However, this may give rise to phantoms due to foreground intersections between different people. This research aims to identify the phantoms from the real intersections.

METHODOLOGY

The proposed method has four steps:

1. Extract foregrounds using GMM and segment side-by-side pedestrians using convex hull analysis.
2. Using waist-plane homography mapping to find the foreground intersections.
3. Calculate the joint occupancy likelihood of each intersection.
4. Use the Quine-McCluskey method [2], along with the joint occupancy likelihood, to find the optimal solution.

JOINT OCCUPANCY LIKELIHOODS

Suppose there are N cameras and F_i represents the foreground observation in camera view i. Let X be the event that there is a pedestrian at intersection region I in the top view. We are interested in finding the posterior probability of event X occurring.

$$P(X/F_1, F_2, \dots, F_N) \propto \prod_{i=1}^{N} [P(f_i|X)P(d_i|X)P(h_i|X)]$$

$$P(f_i|X) = \frac{number\ of\ foreground\ pixels\ in\ A_i}{number\ of\ all\ pixels\ in\ A_i}$$

$$P(d_i|X) = Q_{\chi^2}(d_i, 1) \qquad P(h_i|X) = 1 - Q_G(h_i)$$

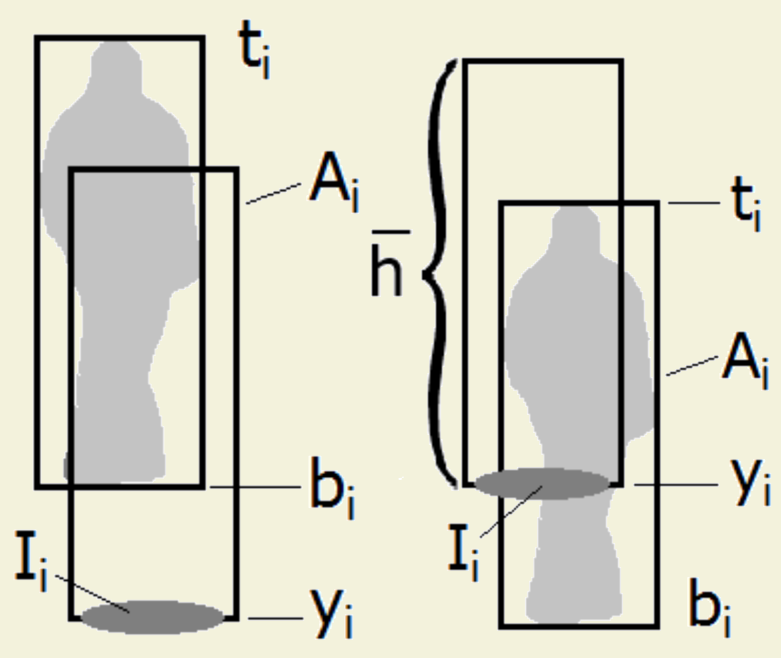


Fig.2 Variables related to d_i and h_i.

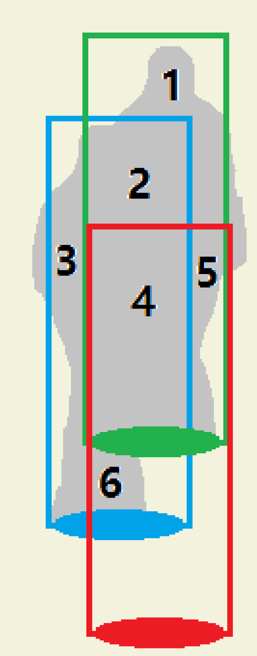
- I_i - Warped foreground intersection
- A_i - Candidate box
- f_i - Foreground pixel set in A_i
- t_i - The top of the foreground box
- b_i - The bottom of the foreground box
- y_i - The bottom of the candidate box
- d_i - Mahalanobis distance from y_i to b_i
- h_i - Distance from y_i to t_i
- $\bar{h}$ - Average height of pedestrians

PRIME CANDIDATE CHARTS

Each foreground region is decomposed into sub-regions according to the overlapping relationship of all the candidate boxes. A prime candidate chart is constructed to select a minimum set of pedestrian candidates to cover all the foreground sub-regions of interest.

The prime candidate chart is updated as follows:

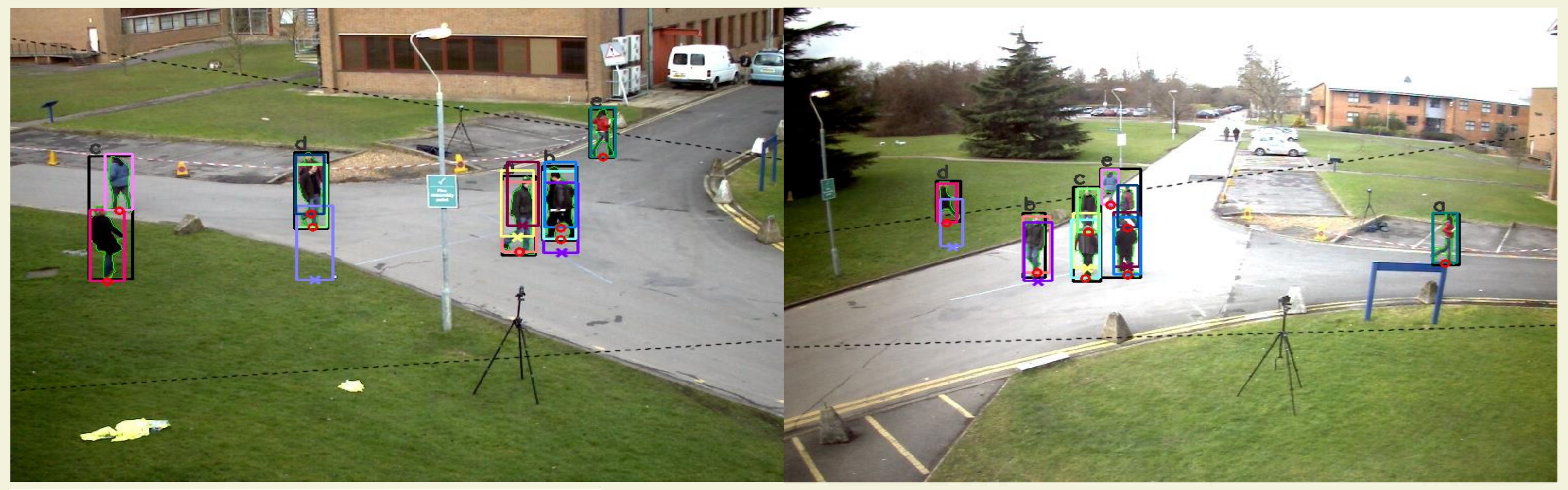
1. Remove the candidates with low occupancy likelihood.
2. Find the essential candidates which cover at least a sub-region that is not covered by other candidates and remove the corresponding rows and columns.
3. Merge the candidates which are contained by others.
4. If there are sub-regions not covered, select a column with two X's. Assume the candidate corresponding to an X is essential and repeat steps 2-3. Then try the other X and select the one with a larger likelihood.



Sub-region:	1	2	3	4	5	6
Red	+	+	+	X	X	X
Green	X	X	+	X	X	+
Blue	+	X	X	X	+	X

Fig.3 Decomposition of a foreground region into sub-regions and the corresponding prime candidate chart. If a candidate covers a given sub-region, an X is placed; otherwise a plus sign.

EXPERIMENTAL RESULTS



Method	Evaluation	RECALL	PRESISION	TER
3DMPP	[3]	N/A	N/A	0.31
POM	[3]	N/A	N/A	0.27
POM	us	0.91	0.82	0.29
MvBN	[4]	0.90	0.97	0.13
Proposed	us	0.96	0.99	0.05

Table 1. Evaluation results.

Fig.4 Pedestrians are labelled with circles; phantoms are labelled with crosses.

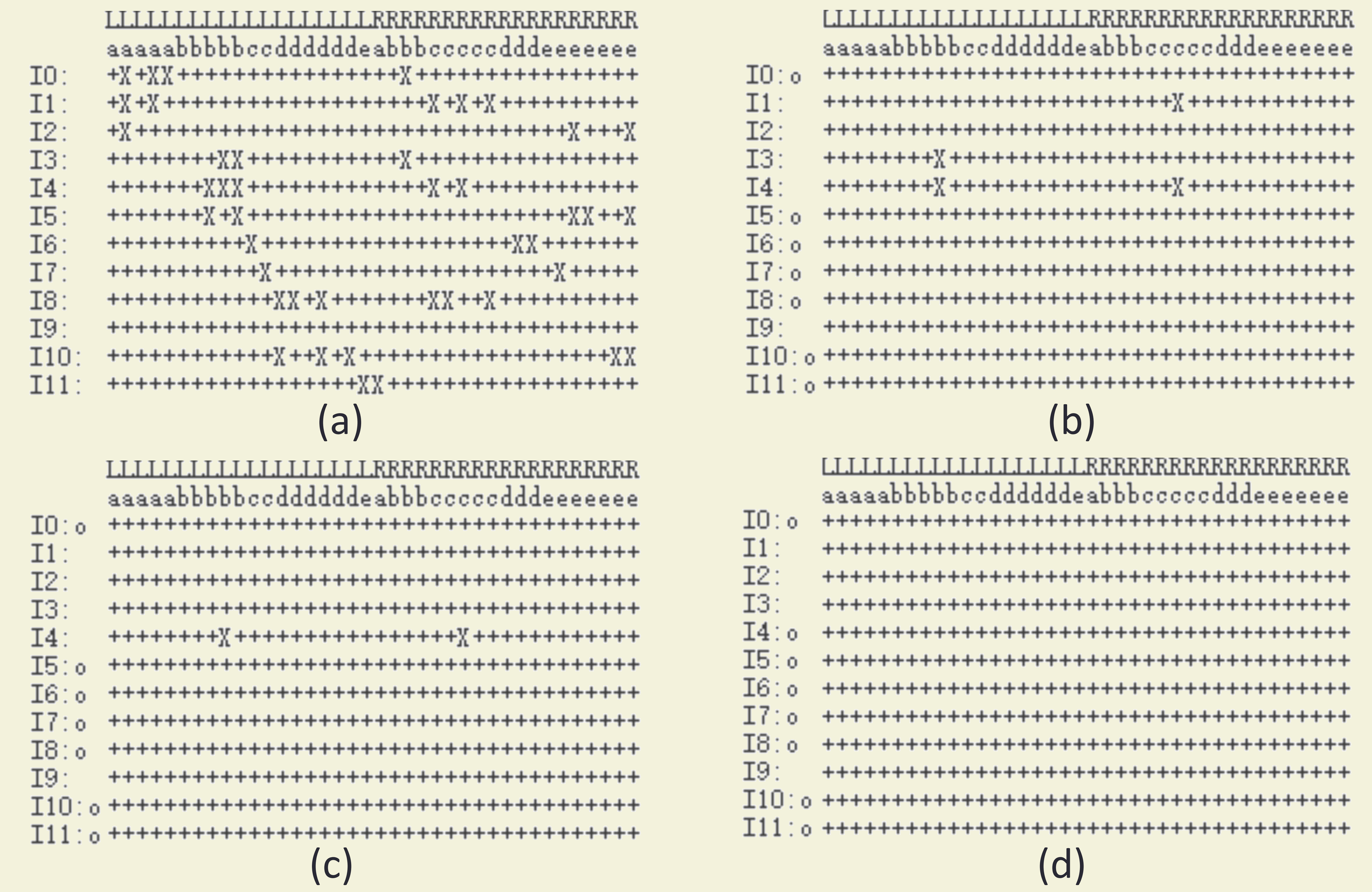


Fig.5 The prime candidate charts after step 1, 2, 3 and 4.

CONCLUSION

The joint occupancy likelihoods and the prime candidate chart used in this paper add robustness to pedestrian localization. Experiment results have shown improved performance.

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Acknowledgement : This work was supported by the National Natural Science Foundation of China (NSFC) under Grant 60975082 and an XJTLU PhD scholarship under Grant PGRS-12-02-07