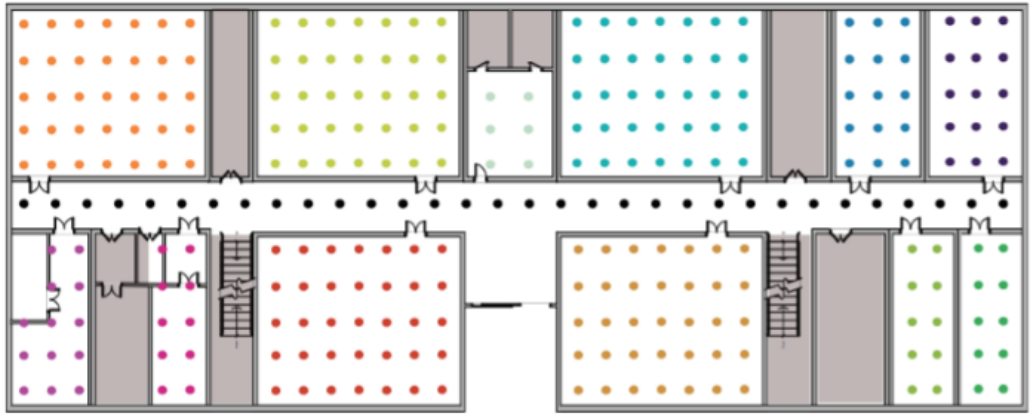
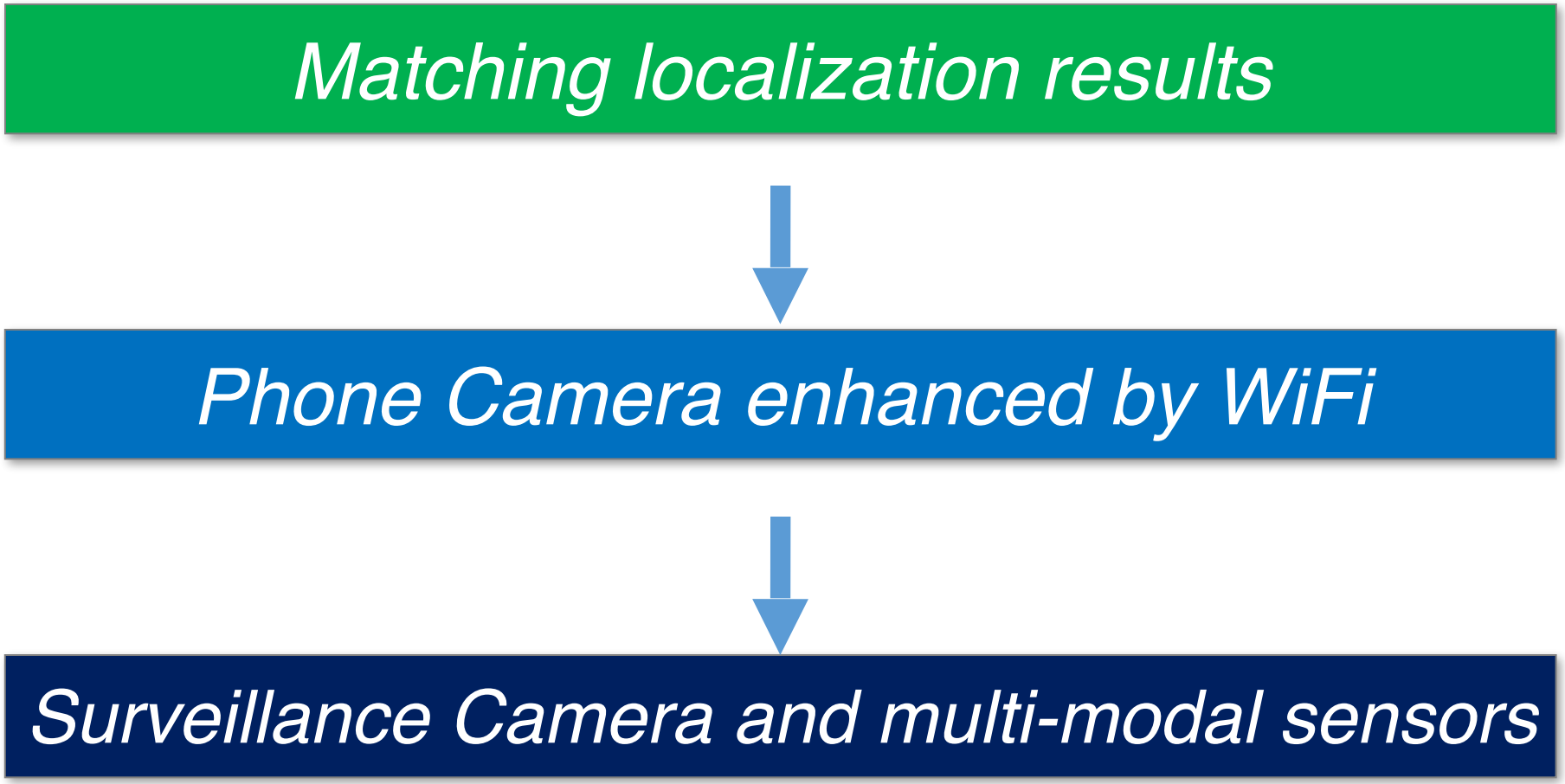
A brief survey on Indoor Localization with wireless signals and cv

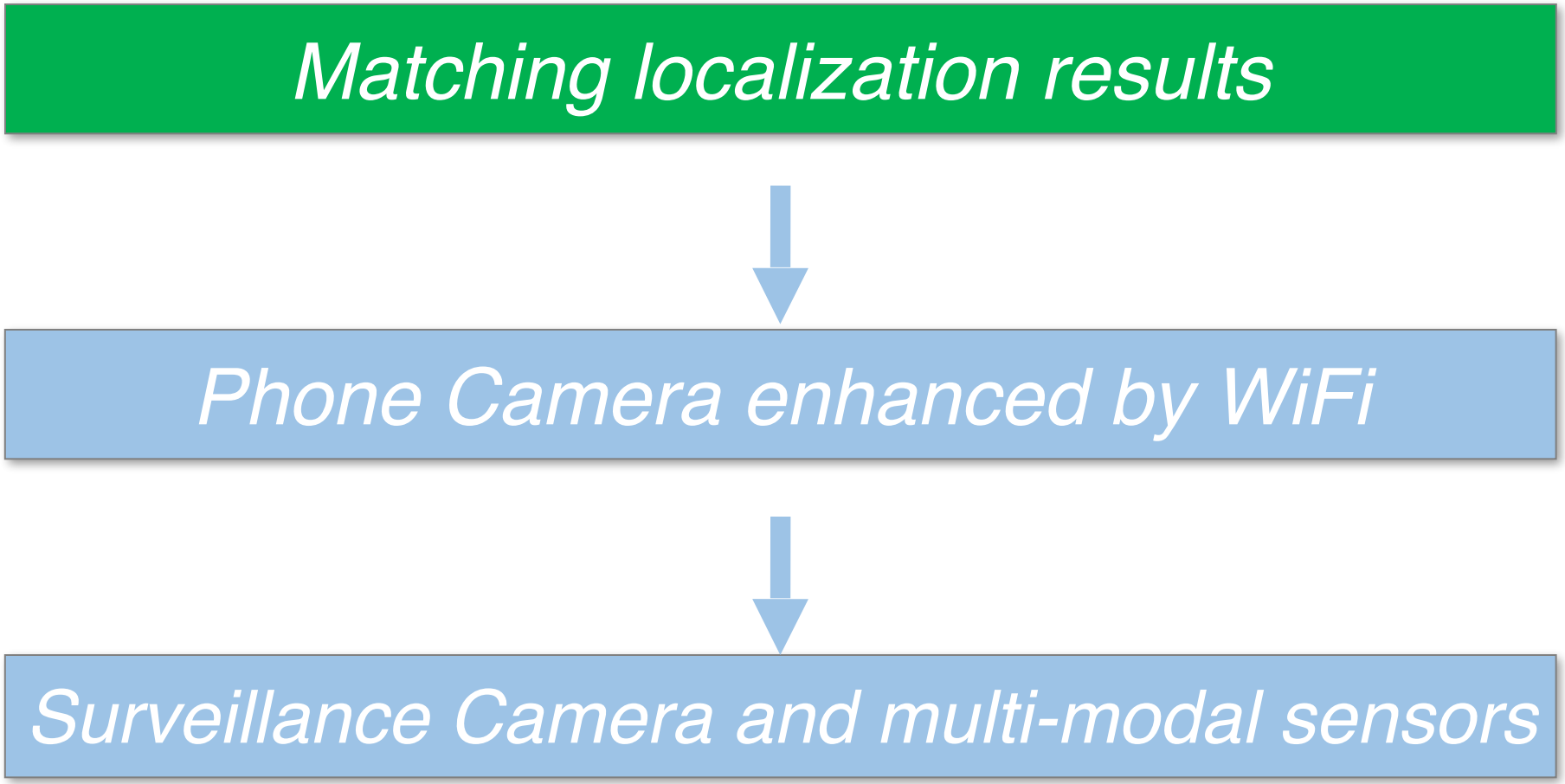
Indoor Localization4.0
wireless signals and cv



Indoor Localization4.0 : wireless signals and cv



Indoor Localization4.0 : wireless signals and cv



Matching localization results

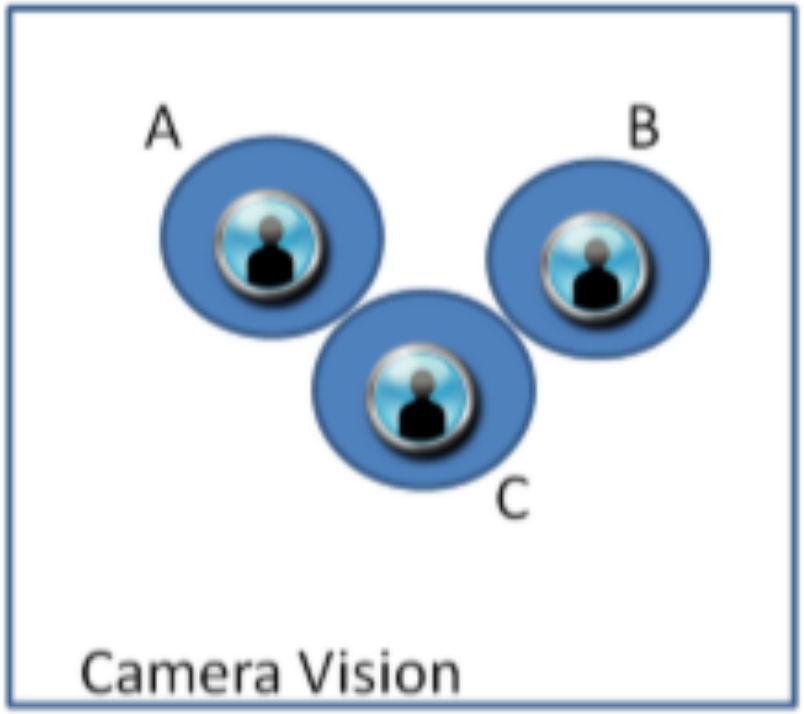
- *Teng, Jin, et al. "EV-Loc: integrating electronic and visual signals for accurate localization." IEEE/ACM Transactions on Networking (TON) 22.4 (2014): 1285-1296.*

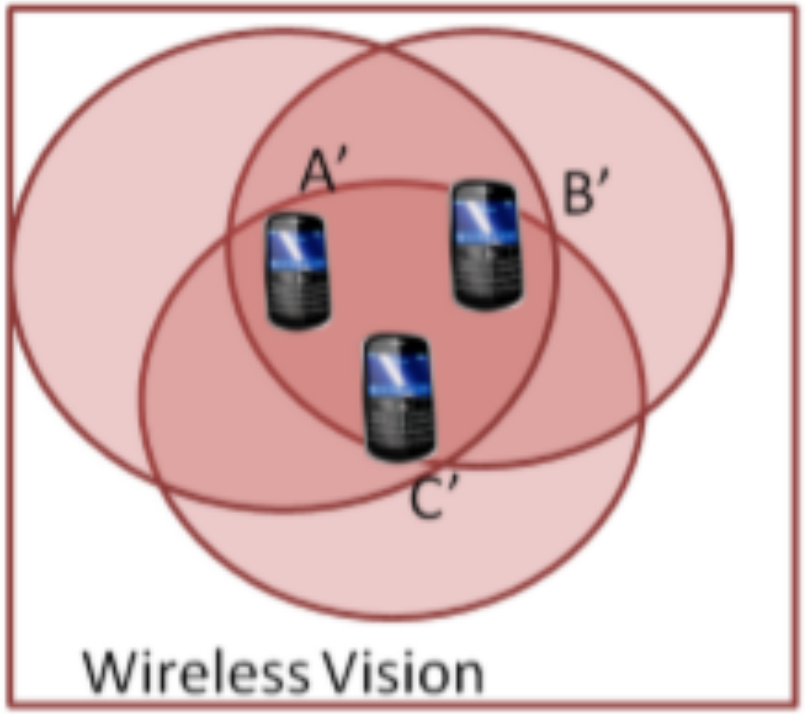
- *Andriluka, Mykhaylo, Stefan Roth, and Bernt Schiele. "People-tracking-by-detection and people-detection-by-tracking." 2008 IEEE Conference on computer vision and pattern recognition. IEEE, 2008.*

- *……*

Matching localization results

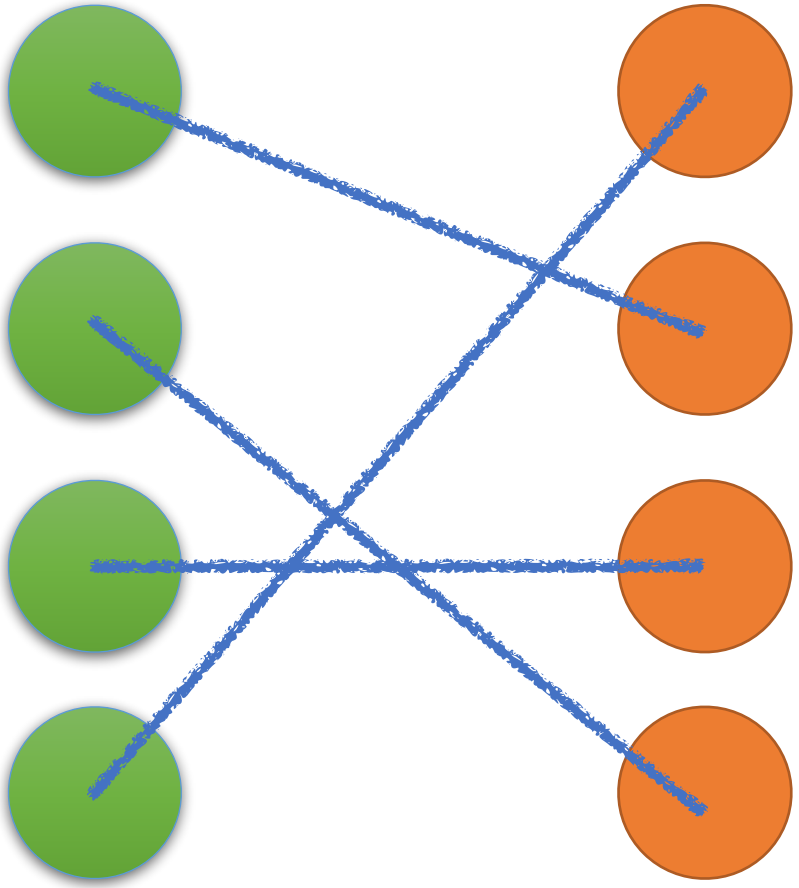
Traditional cv can detect people with visual signals.
Using Hungarian Algorithm to match localization results from camera vision and wireless vision.





Matching localization results

Traditional cv can detect people with visual signals.
Using Hungarian Algorithm to match localization results from camera vision and wireless vision.



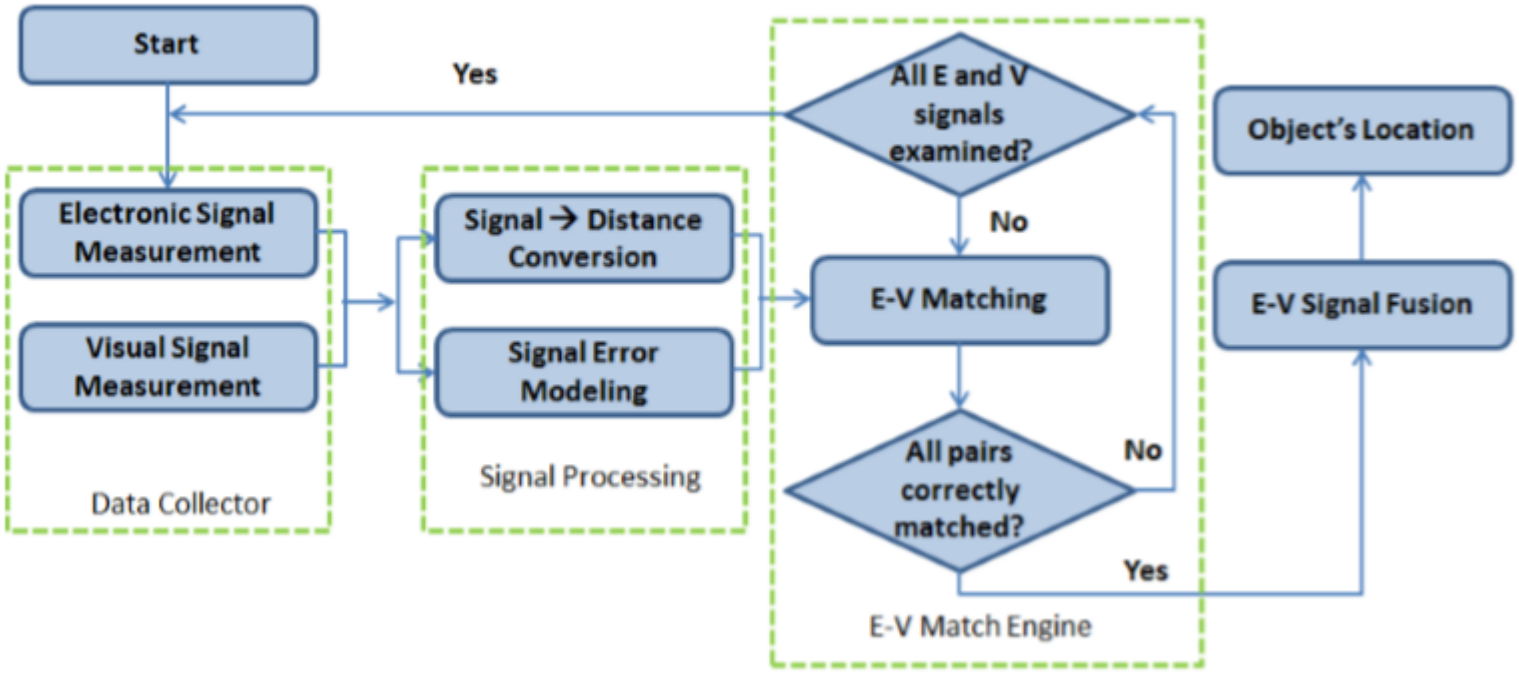
$$\arg\min_{\pi_i} \sum_{i=1}^{n} \|x_i - y_{\pi_i}\|$$

$$z_i = \alpha x_i + \beta y_{\pi_i}$$

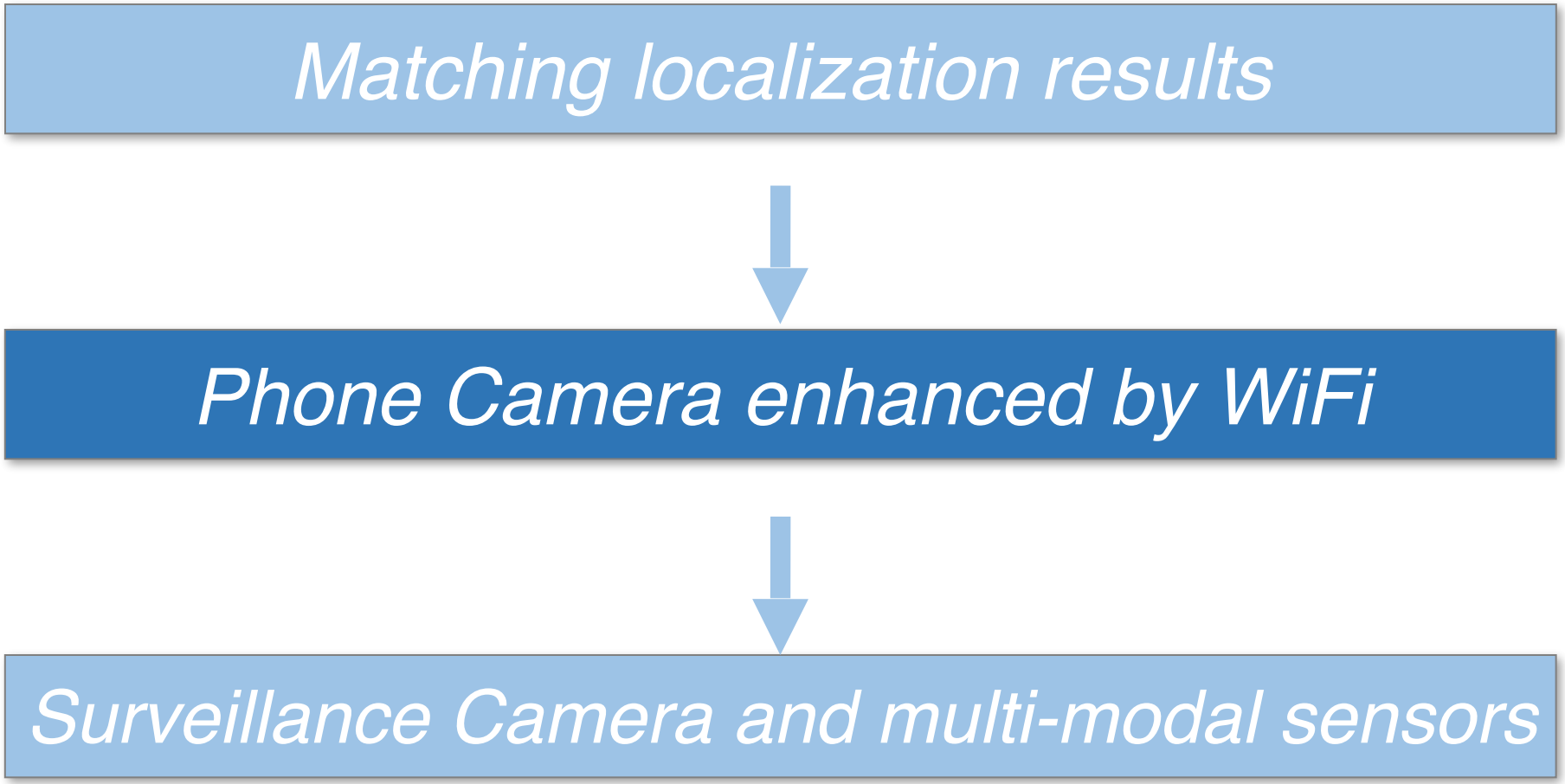
Matching localization results

Assume here that the electronic signals and visual signals are complete with no false negatives or positives, i.e., there are no "ghost" or missing objects.

Generate a similarity matrix between every pair of consecutive visual frames.



Indoor Localization4.0 : wireless signals and cv

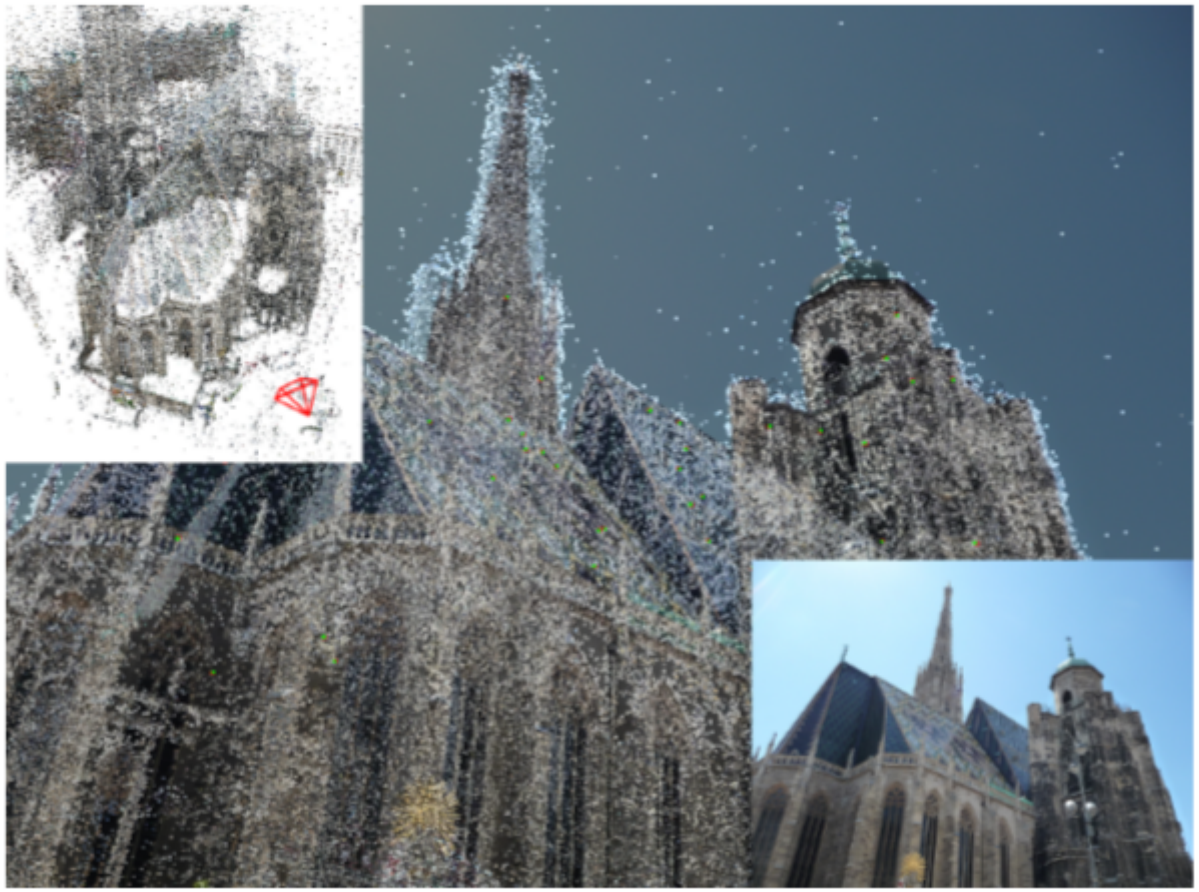


Phone Camera enhanced by WiFi

- *Xu, Han, et al. "Enhancing wifi-based localization with visual clues." Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing. ACM, 2015.*
- *Xu, Han, et al. "Indoor localization via multi-modal sensing on smartphones." Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing. ACM, 2016.*
- *Sattler, Torsten, Bastian Leibe, and Leif Kobbelt. "Fast image-based localization using direct 2d-to-3d matching." 2011 International Conference on Computer Vision. IEEE, 2011.*
- *……*

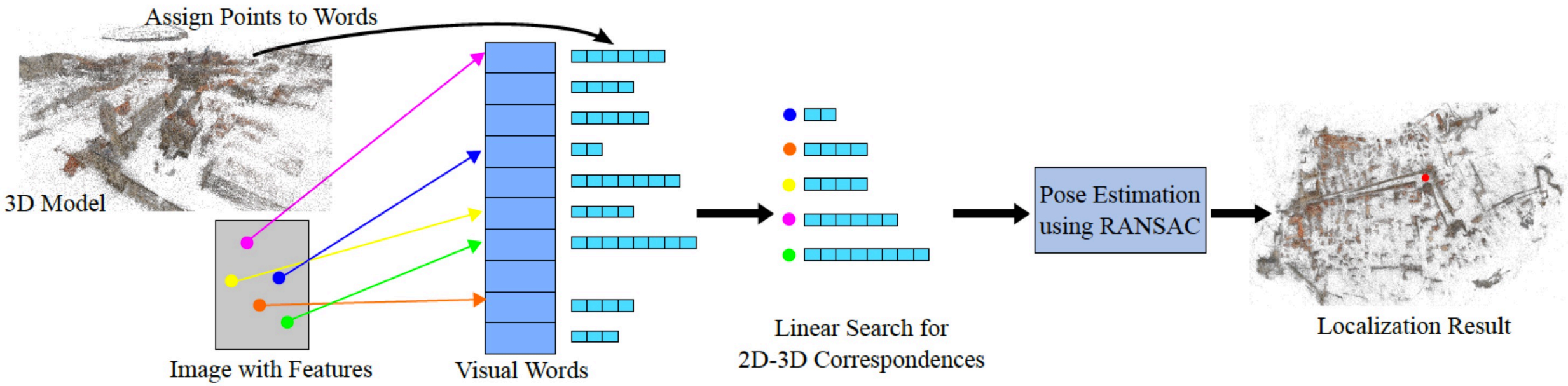
Phone Camera enhanced by WiFi

- *image-based localization using 2d-to-3d matching*

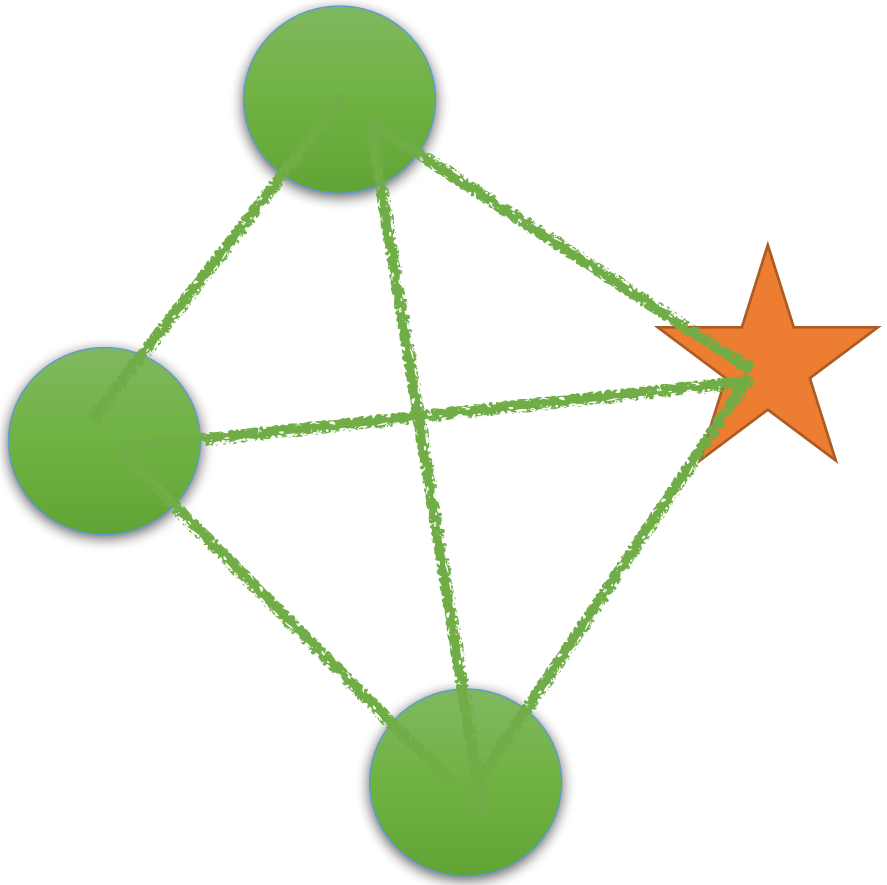


Phone Camera enhanced by WiFi

- *image-based localization using 2d-to-3d matching*

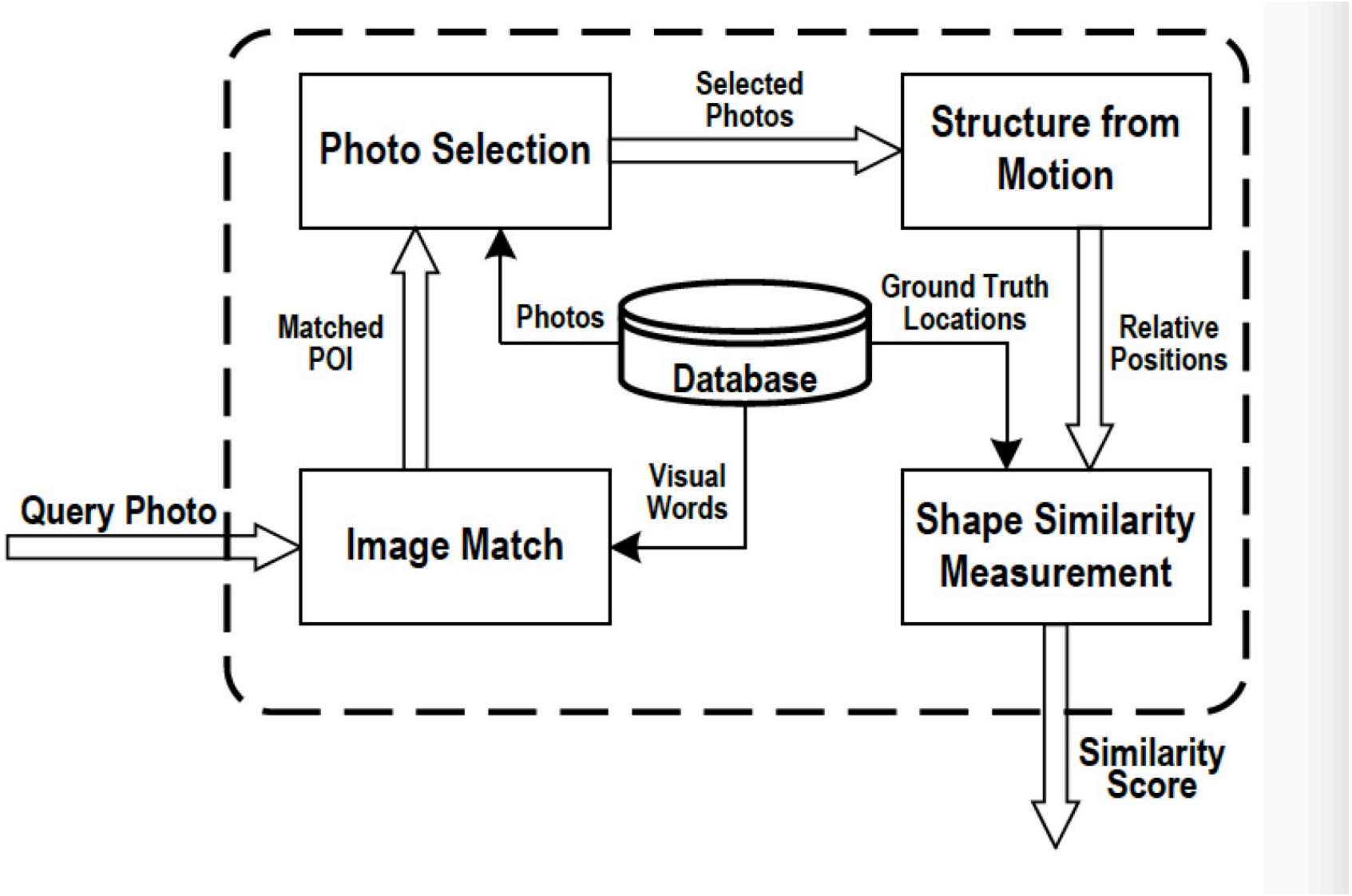


Phone Camera enhanced by WiFi

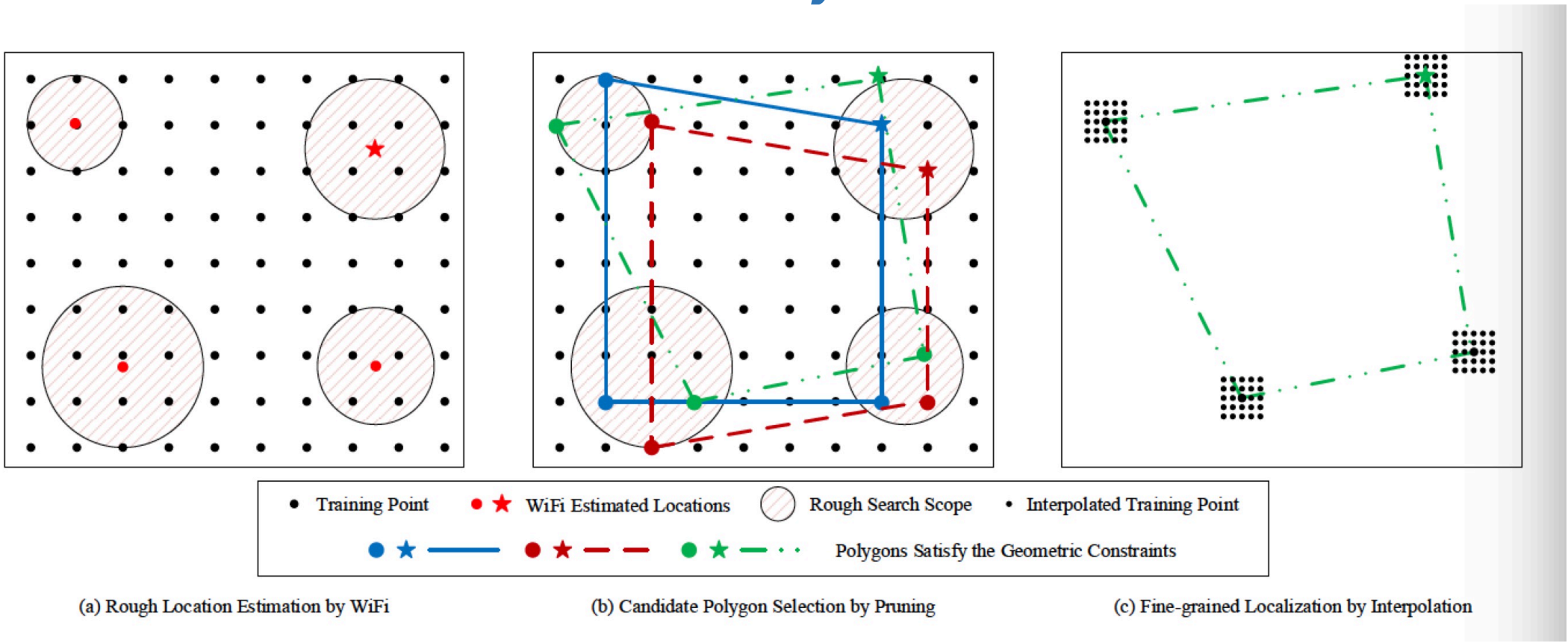


- *SfM*
- *hundreds of overlapping images*
- *polygon (100 photos, lack of scaling, rotation)*

Phone Camera enhanced by WiFi

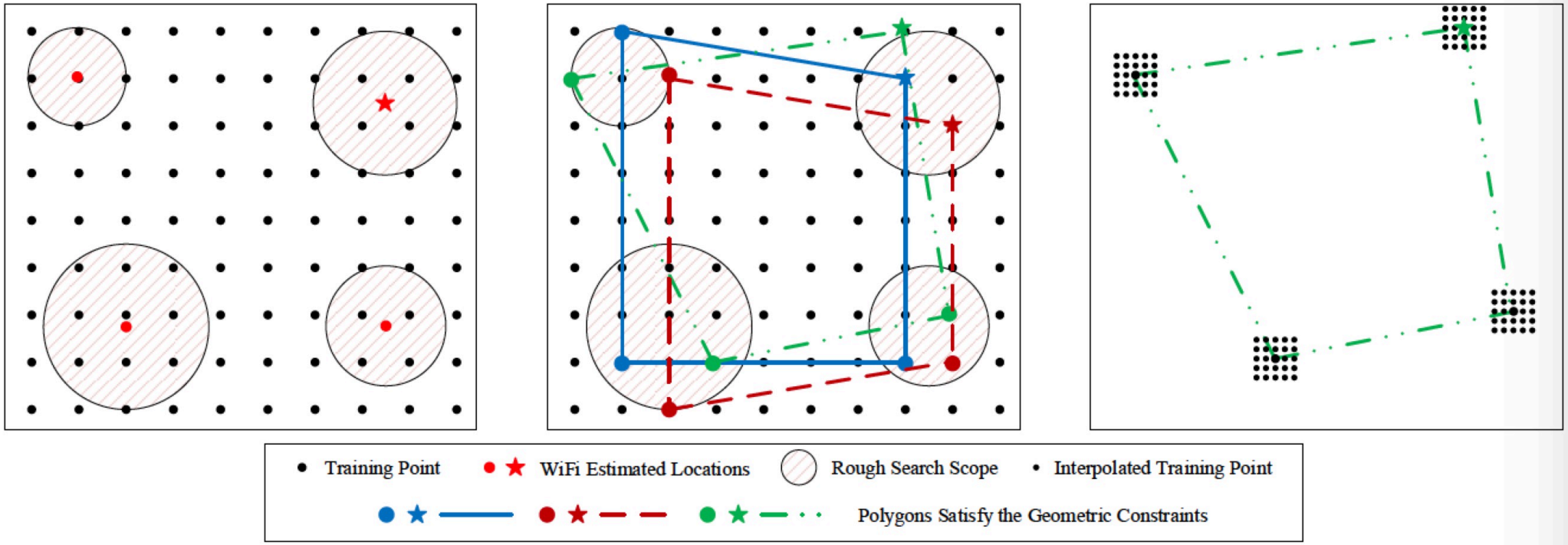


Phone Camera enhanced by WiFi



- *Step 1: Rough Location Estimation by WiFi*
- *Step 2: Candidate Polygon Selection by Pruning*
- *Step 3: Fine-grained Localization by Interpolation*

Phone Camera enhanced by WiFi



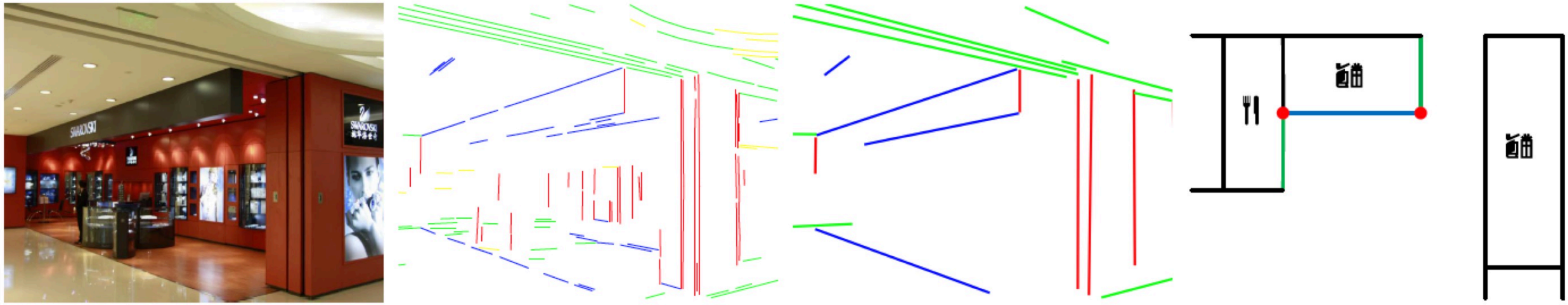
(a) Rough Location Estimation by WiFi (b) Candidate Polygon Selection by Pruning (c) Fine-grained Localization by Interpolation

$$\textbf{Minimize} \quad \sum_{\forall i} \left[f\left(a_i\right) - f\left(b_i\right)\right] \left[f\left(a_i\right) - f\left(b_i\right)\right]^T$$

Subject to

$$\forall i, j \quad : \quad (1-\alpha)\frac{|E_{i,j}|}{|E_{1,2}|} \leqslant \frac{|(b_i, b_j)|}{|(b_1, b_2)|} \leqslant (1+\alpha)\frac{|E_{i,j}|}{|E_{1,2}|}$$

Phone Camera enhanced by WiFi

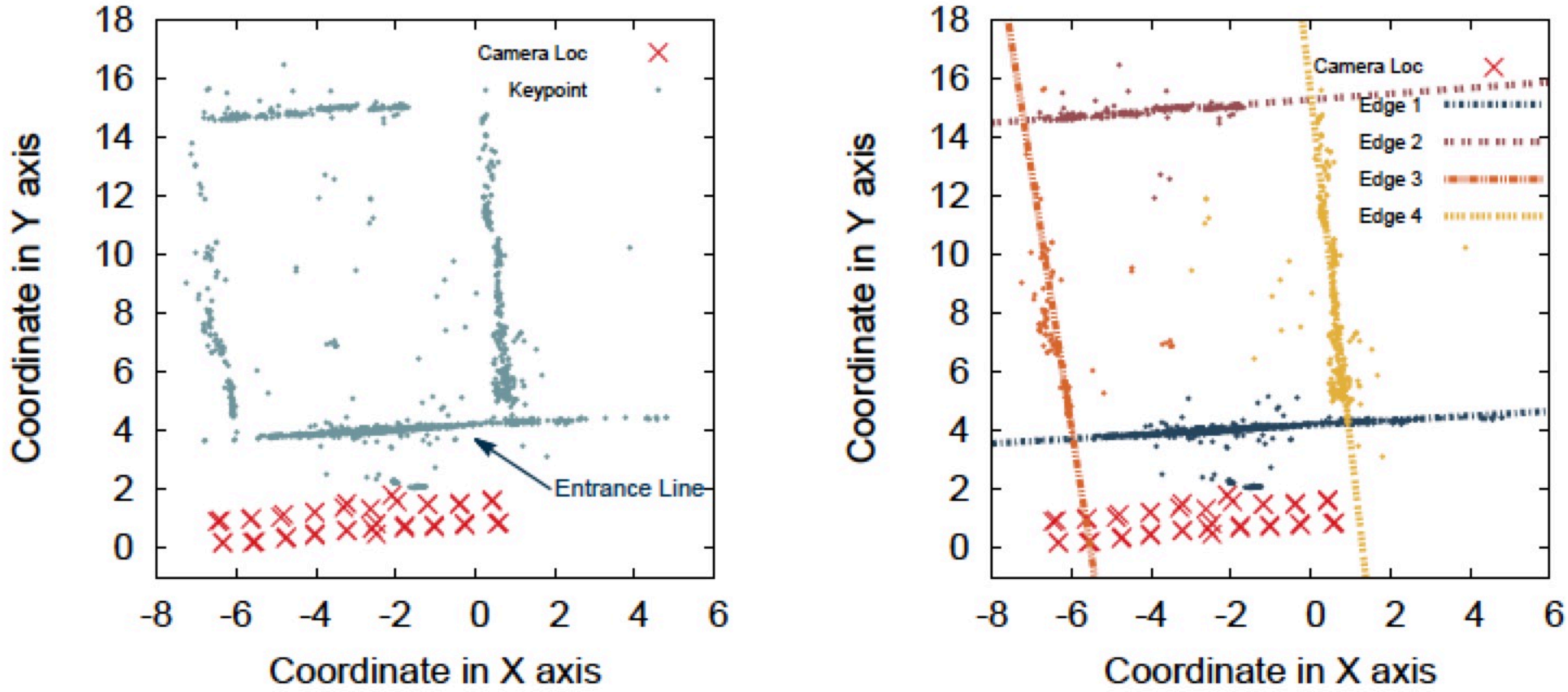


(a) Original Image (b) Extracted lines (c) After Processing (d) Map to Floor Plan

Figure 3. Indoor Geometric Reasoning by Line Segments

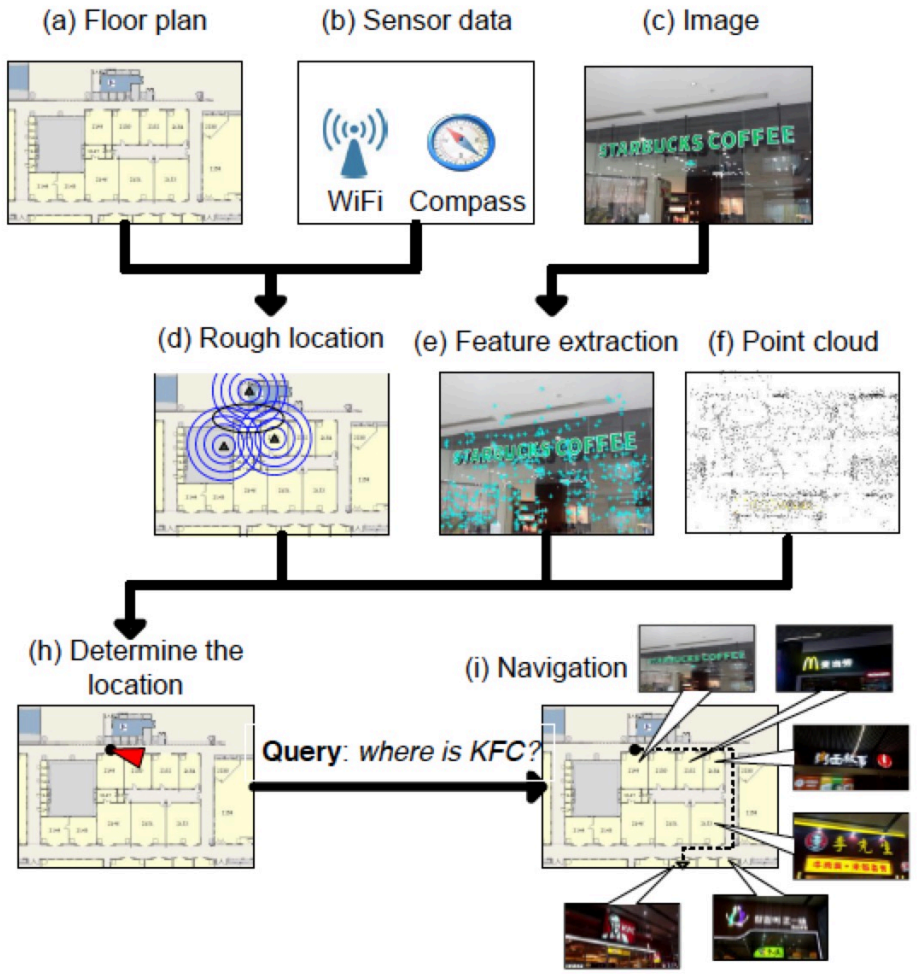
Estimation of scaling
Utilizing floor plan and sensor data to reason indoor geometric scaling

Phone Camera enhanced by WiFi



Estimation of rotation:
Find the entrance, cluster “K-Edges”

Phone Camera enhanced by WiFi

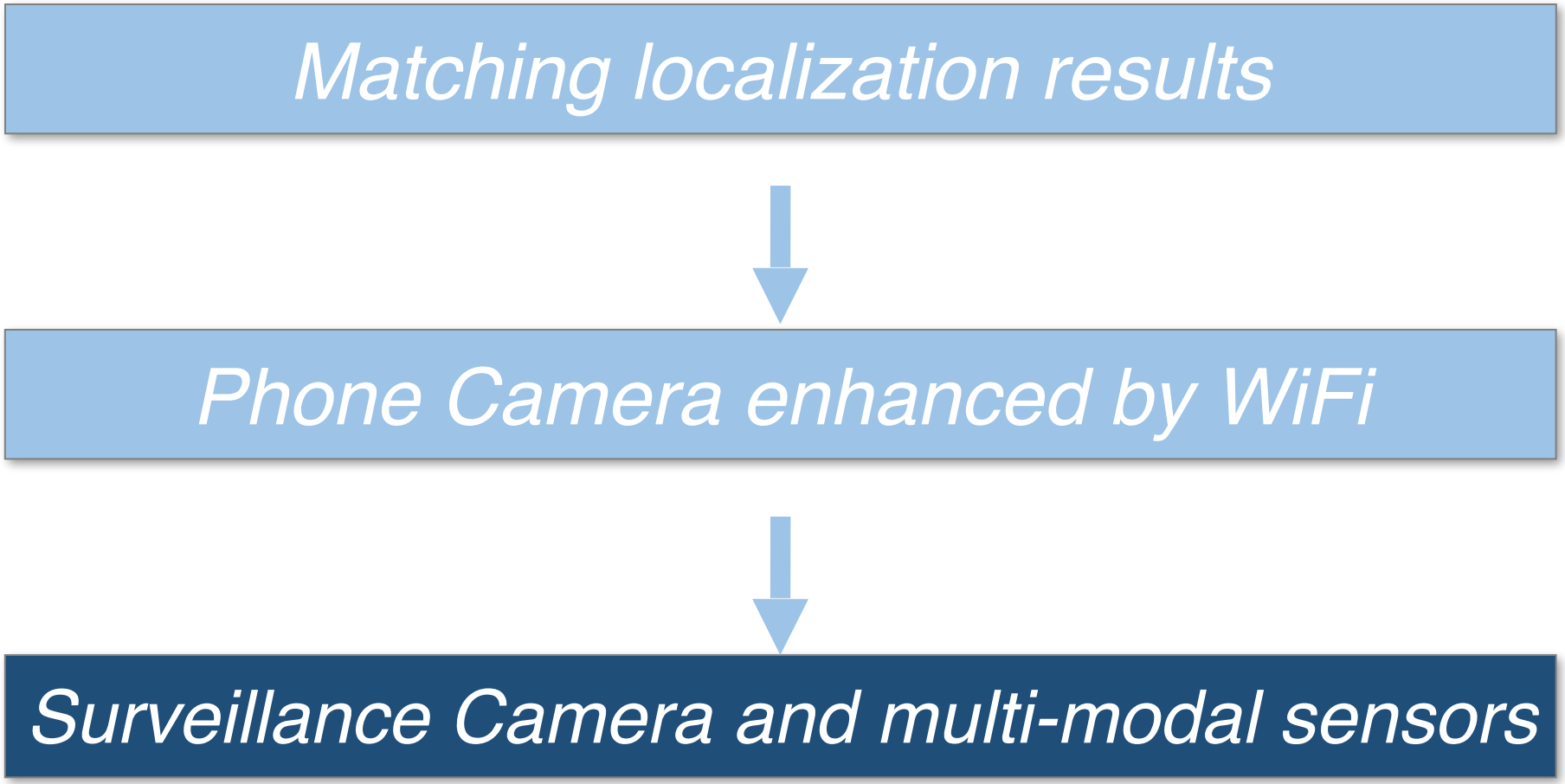


$$\textbf{Minimize} \quad \left| p_i - \sum_{j \in \mathbb{N}(i)} W_{ij} p_i^{\mathbb{N}(j)} \right|$$

$$\textbf{Subject to} \quad \sum_{j \in \mathbb{N}(i)} W_{ij} = 1$$

Rough location：*multi-modal*

Indoor Localization4.0 : wireless signals and cv

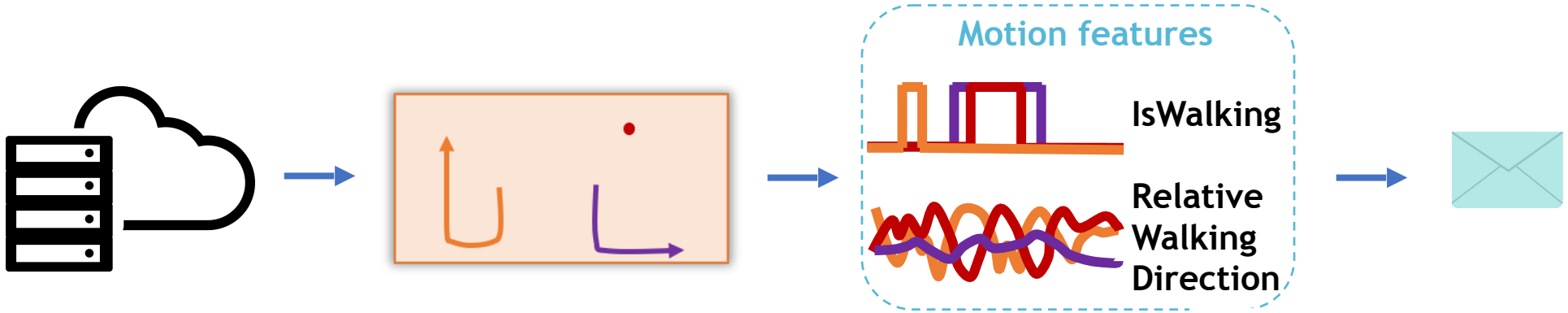


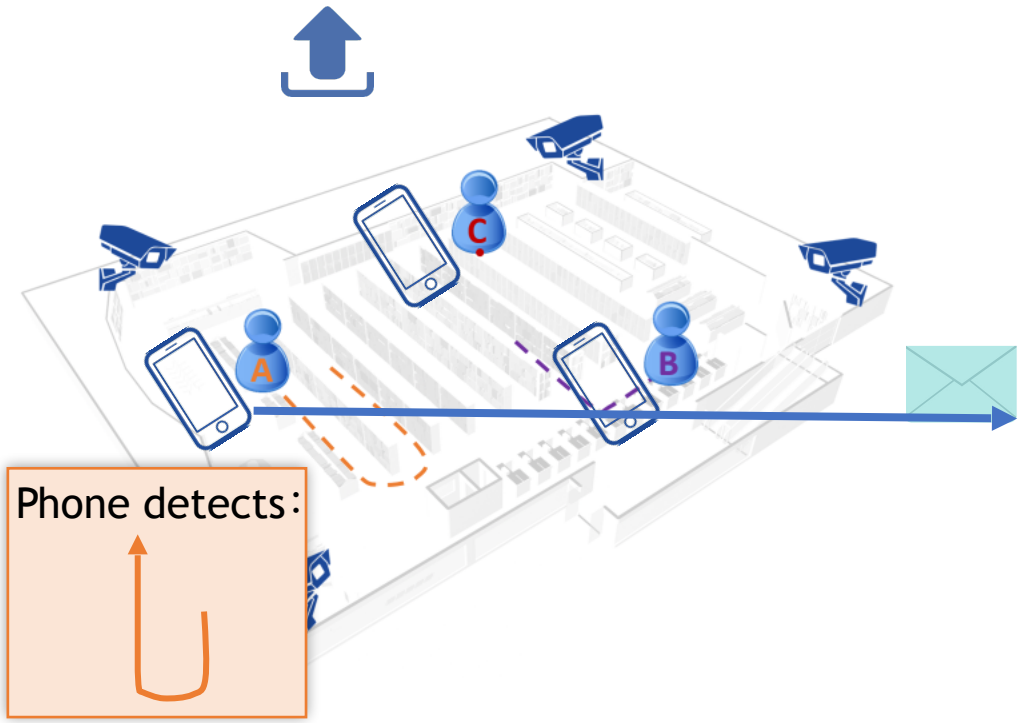
Surveillance Camera and multi-modal sensors

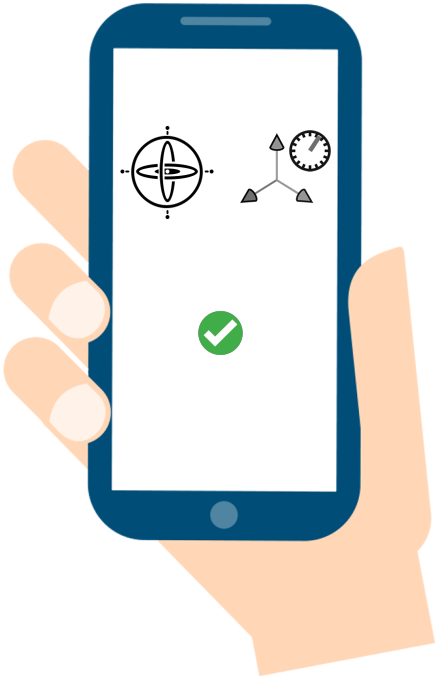
- *Enabling Public Cameras to Talk to the Public*
- *Self-deployable Indoor Localization with Fused Observation*
- *……*

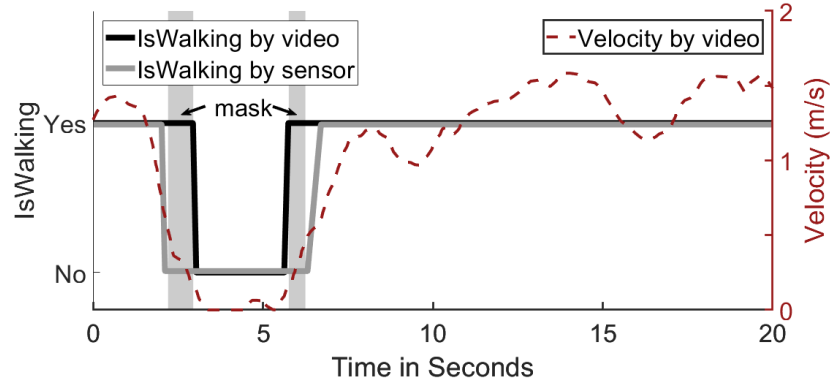
Surveillance Camera and multi-modal sensors

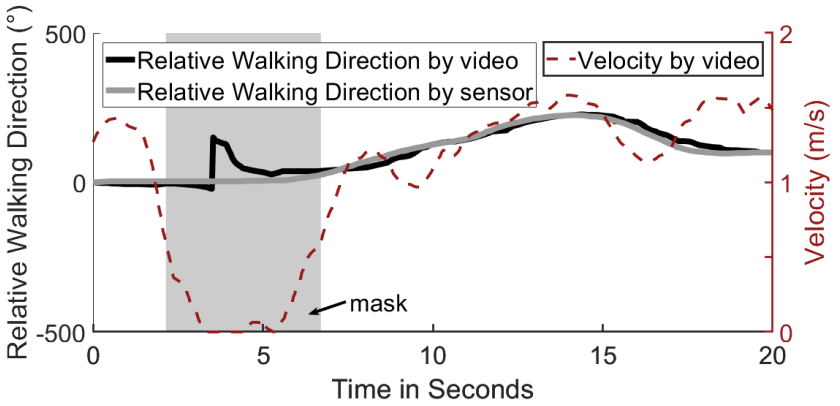
	优势	劣势
CV技术	1.可视化效果好，通过投影矩阵获得全局坐标 2.机器学习方法很准确 3.检测结果鲁棒性较高	1.只能检测、难以识别 2.运行速度较慢
PDR技术	1.通过硬件ID实现人物区分 2.采集数据以及刻画轨迹快 3.相对路径较鲁棒	1.无全局坐标 2.手机拿着的方式影响很大 3.存在积分漂移
WiFi技术	1.通过硬件ID实现人物区分 2.有全局坐标	1.采样速度很慢 2.指纹数据库大量维护成本 3.无线信号的波动性，定位不鲁棒


Motion features
IsWalking
Relative
Walking
Direction


A
B
C
Phone detects:




IsWalking by video
IsWalking by sensor
Velocity by video
mask
IsWalking
Yes
No
Velocity (m/s)
Time in Seconds


Relative Walking Direction by video
Relative Walking Direction by sensor
Velocity by video
mask
Relative Walking Direction (°)
Velocity (m/s)
Time in Seconds

Indoor Localization with wireless signals and cv