CPS: Synergy: Distributed Sensing, Learning and Control in Dynamic Environments

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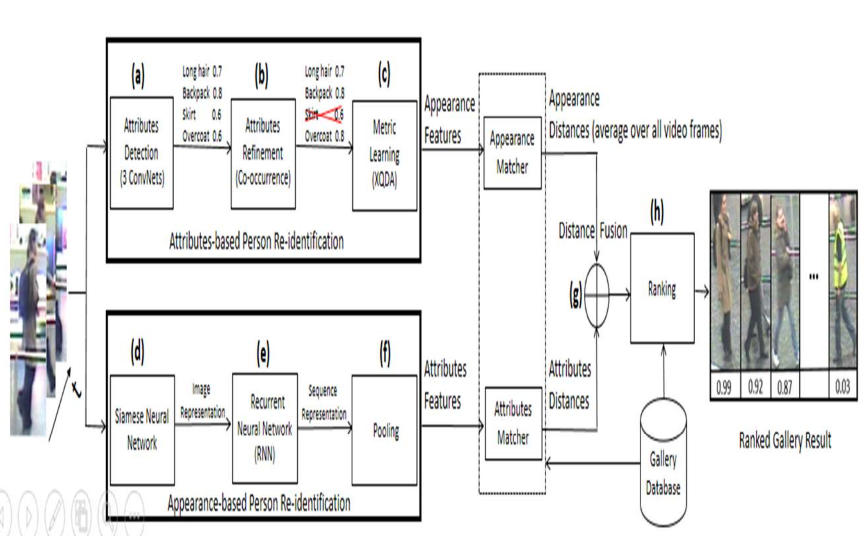
Objectives

- To develop a synergistic framework for fixed and mobile sensors to collaborate on scene understanding
- To perform a tight integration of perception and action and to advance cyber-physical systems by exploring a class of synergies across: control, video understanding, and data management under uncertainty
- To experimentally validate the framework for surveillance domain using a testbed with autonomous agents

Attributes Co-occurrence Pattern Mining for Video-based Person Re-identification

- Visual attributes (e.g., hair and shirt color) offer a human understandable way to recognize people
- Design three ConvNets for attributes detection
- Exploit co-occurrence information to improve attributes' descriptive capabilities
- Propose an attributes-based method and then combine it with an appearance-based model for final prediction
- Achieve better and more consistent results on two public datasets

(IEEE AVSS, 2017)



Methods	r=1	r=5	r=10	r=20
Attributes	3.7	9.7	14	24.2
Ours without refinement	59.7 (0.034)	85.3	93.6	98
Ours	**60.3** (0.035)	85.3	93.6	98
RCNN [17] CVPR 2016	58.3 (0.035)	84.6	92	96.7
TDL [26] CVPR 2016	56.3	**87.6**	**95.6**	**98.3**
TAPR [9] ICIP 2016	55	87.5	93.8	97.2
SI^2DL [27] IJCAI 2016	48.7	81.1	89.2	97.3

Results on iLIDs-VID dataset

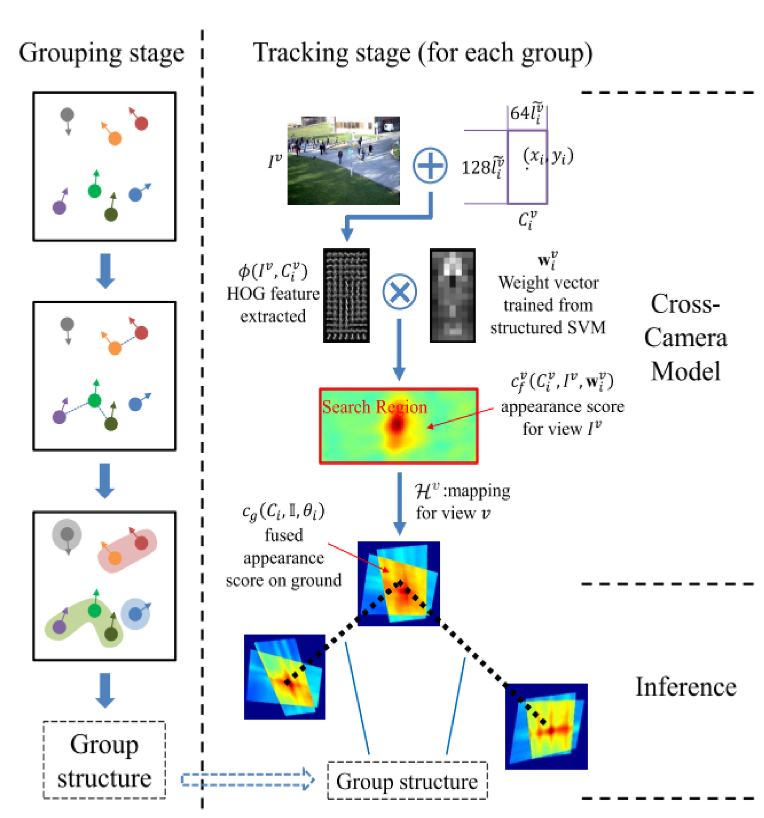
Methods	r=1	r=5	r=10	r=20
Attributes	4.3	15.3	31	43
Ours without refinement	72.7 (0.041)	93	96.3	98.3
Ours	73.2 (0.038)	93	96.3	98.3
RCNN [17] CVPR 2016	70.6 (0.051)	92.3	95.3	97.3
TDL[26] CVPR 2016	56.3	87.6	95.6	98.3
TAPR[9] ICIP 2016	55	87.5	93.8	97.2
SI^2DL [27] IJCAI 2016	**76.7**	**95.6**	**96.7**	**98.9**

Results on PRID 2011 dataset

Group Structure Preserving Pedestrian Tracking in a Multicamera Video Network

- A new cross-camera model is proposed, which enables the fusion of the confidence information from all camera views
- Group structures on the ground plane provide extra constraints between pedestrians
- The structured support vector machine is adopted to update model
- Excellent results are obtained on challenging data

(IEEE Trans. CSVT, 2017)



Evaluation Category	Tracking Individually			Tracking in Groups		
	MOTP	MOTA	Distance	MOTP	MOTA	Distance
View 1	82.13%	76.54%	167.91	**82.89%**	**79.42%**	**136.41**
View 2	81.89%	70.75%	90.36	**82.42%**	**83.42%**	**68.17**
Ground plane	84.33%	59.58%	36.11	**85.14%**	**72.71%**	**26.44**

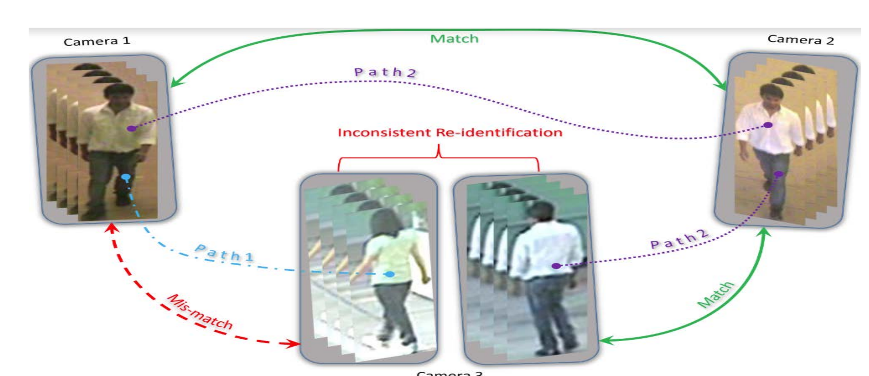
Results on PETS 2009 dataset

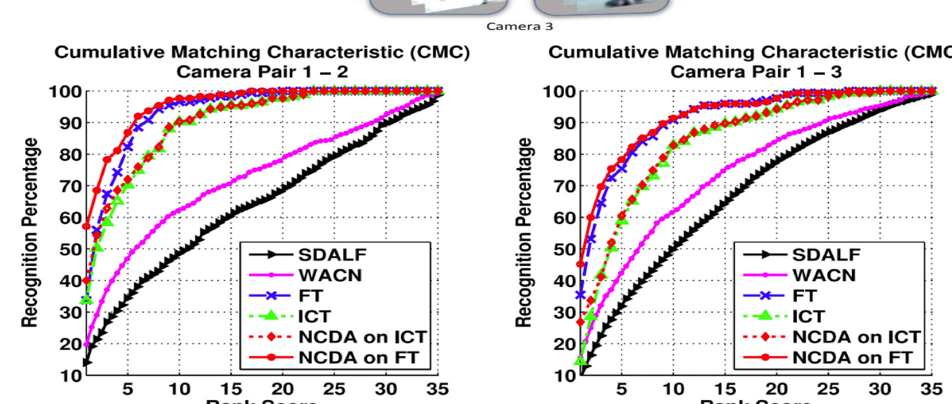
Network Consistent Re-identification & Continuous Adaptation of Person Identification with Minimal Labeling

Network Consistent Re-identification

- Address consistent matching as a data-association task over network perspective
- Formulate an optimization problem to maximize overall pairwise similarity while abiding by network level constraints

(IEEE TPAMI, 2016)



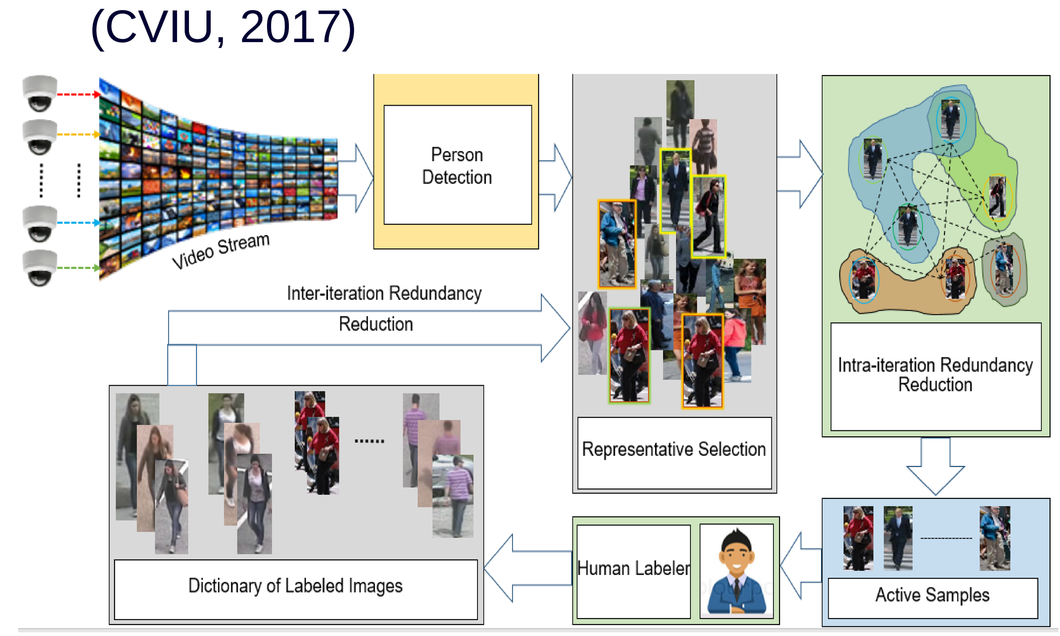


Results on WARD dataset

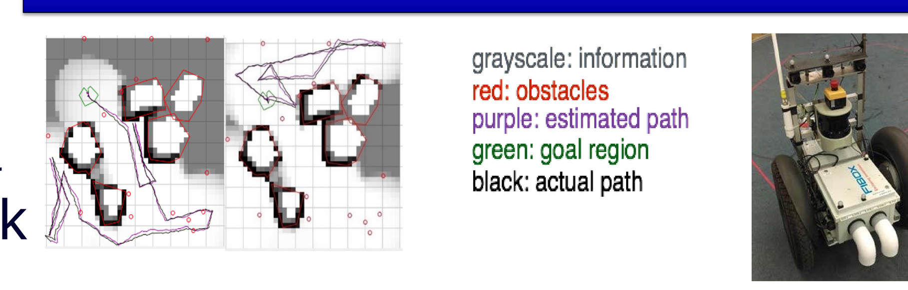
Continuous Adaptation of Person Identification with Minimal Labeling

- Propose a sparse representative selection based approach
- Formulate as a convex optimization problem, which endorses selection of samples with the most variabilities

(CVIU, 2017)



Exploration with Localization Guarantees



- Key results:
  - General info gathering framework
    - Maximizing information goals
    - Probabilistic guarantees
  - Asymptotic guarantees as the # of samples increases
  - Bound on the reward for partially known environments
    - Speeds computation (>1000x) to real time
  - Validation by simulation/experiment

(IEEE Trans. Control Sys., 2018)

Path Optimization

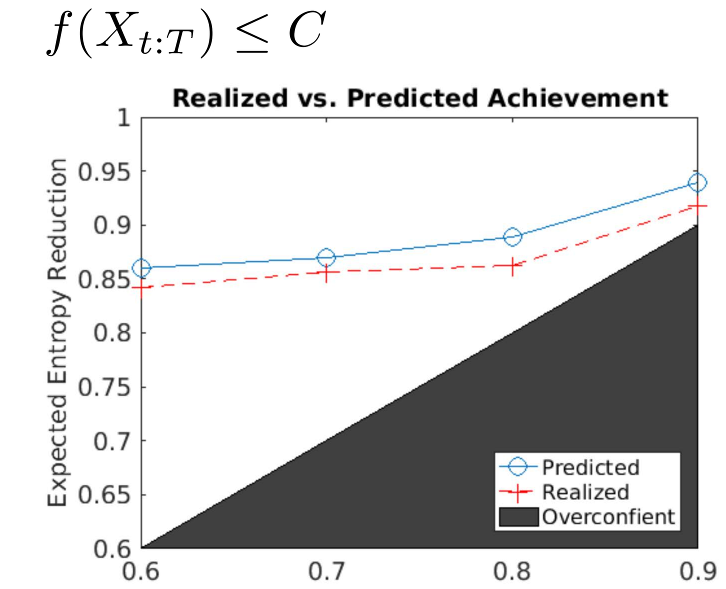
$$X^*_{t:T} = \operatorname{argmax}_{X_{t:T}} R(X_{t:T})$$

Information Reward

$$R(X_{t:T}) = H(Y_{l(t)}) - \mathop{\mathbb{E}}_{Z_{t:T}} \left[H(Y_{n(T)}) \right]$$

Information constraint

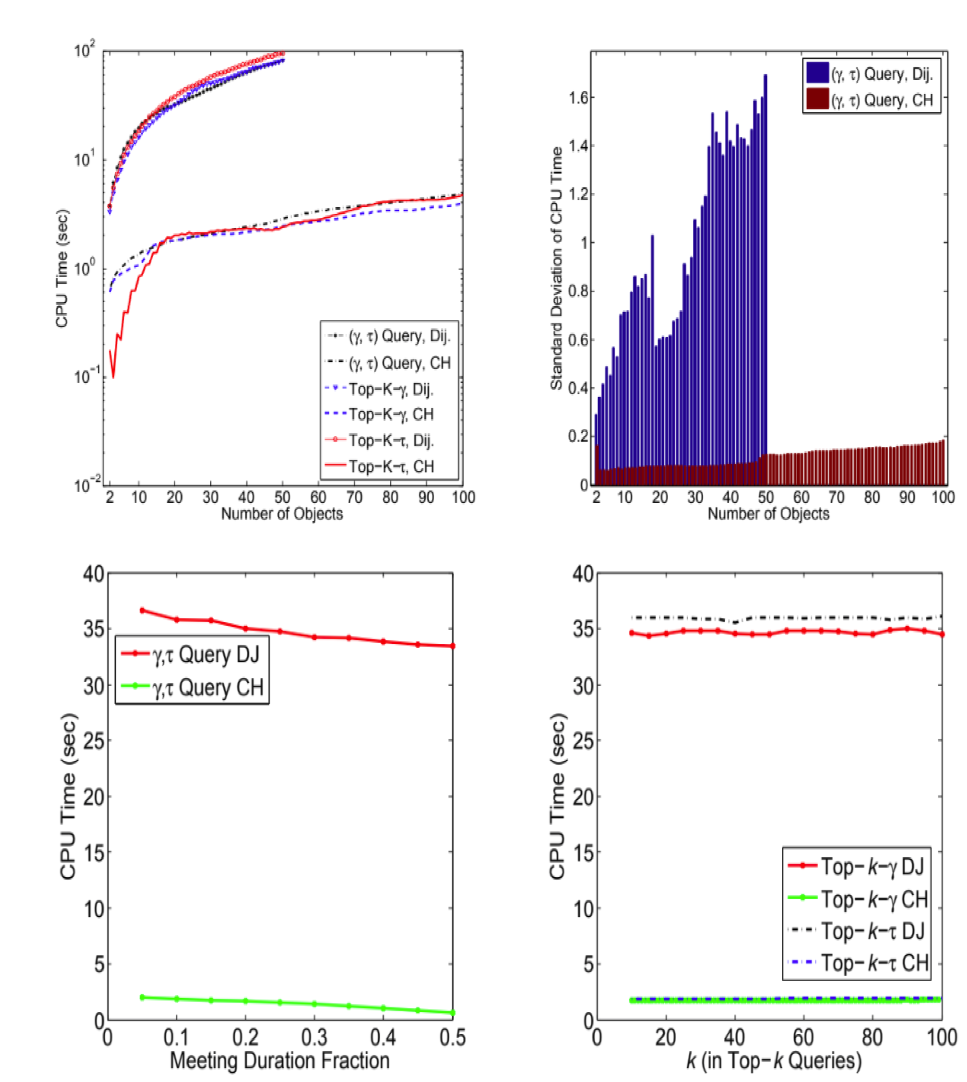
$$f(X_{t:T}) \leq C$$



Assembly Queries: Planning & Discovering Assemblies of Moving Objects Using Partial Information

- Introduce the novel and important class of assembly queries:
  - "Assembly discovery" (determine whether two or more moving objects could have had a meeting within a region of interest)
  - "Assembly planning" (arrange for meetings for a group of friends visiting a city without violating their remaining schedules)
- Provide efficient solutions given incomplete trajectory information, using the topology of the underlying transportation network
- Present a formal model for the general problem and prove the correctness of our algorithm
- Utilize a preprocessing method based on Contraction Hierarchies to gain orders of magnitude speed up over the naïve Dijkstra-based methods

(ACM SIGSPATIAL, 2017)



Results on road network data for California and Nevada

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