



Focusing on Tracks for Online Multi-Object Tracking

Kyujin Shim, Kangwook Ko, YuJin Yang Changick Kim

Computational Intelligence Lab.

Korea Advanced Institute of Science and Technology (KAIST)

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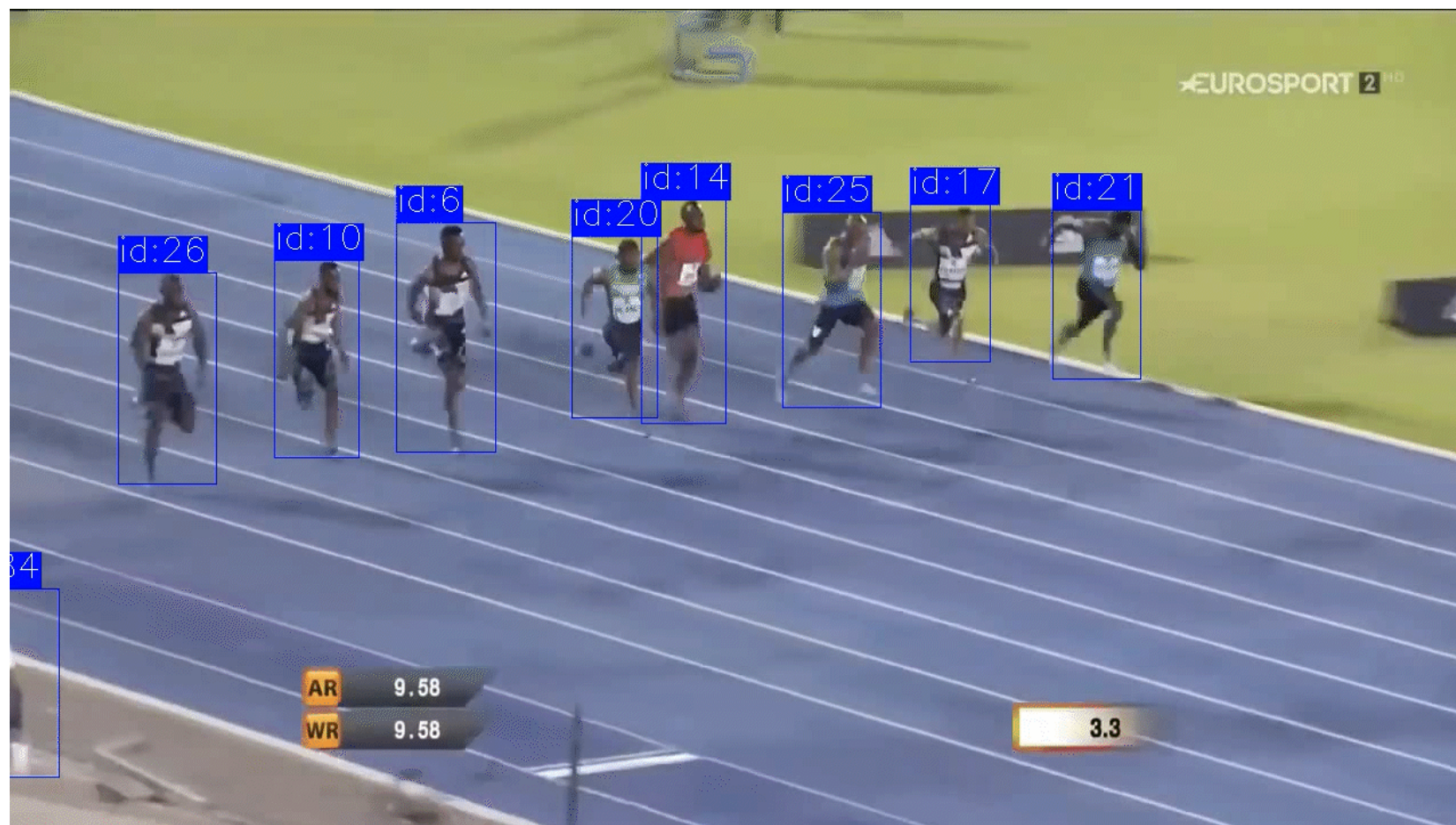


Introduction



Multi-object Tracking

- Tracking multiple objects in single camera

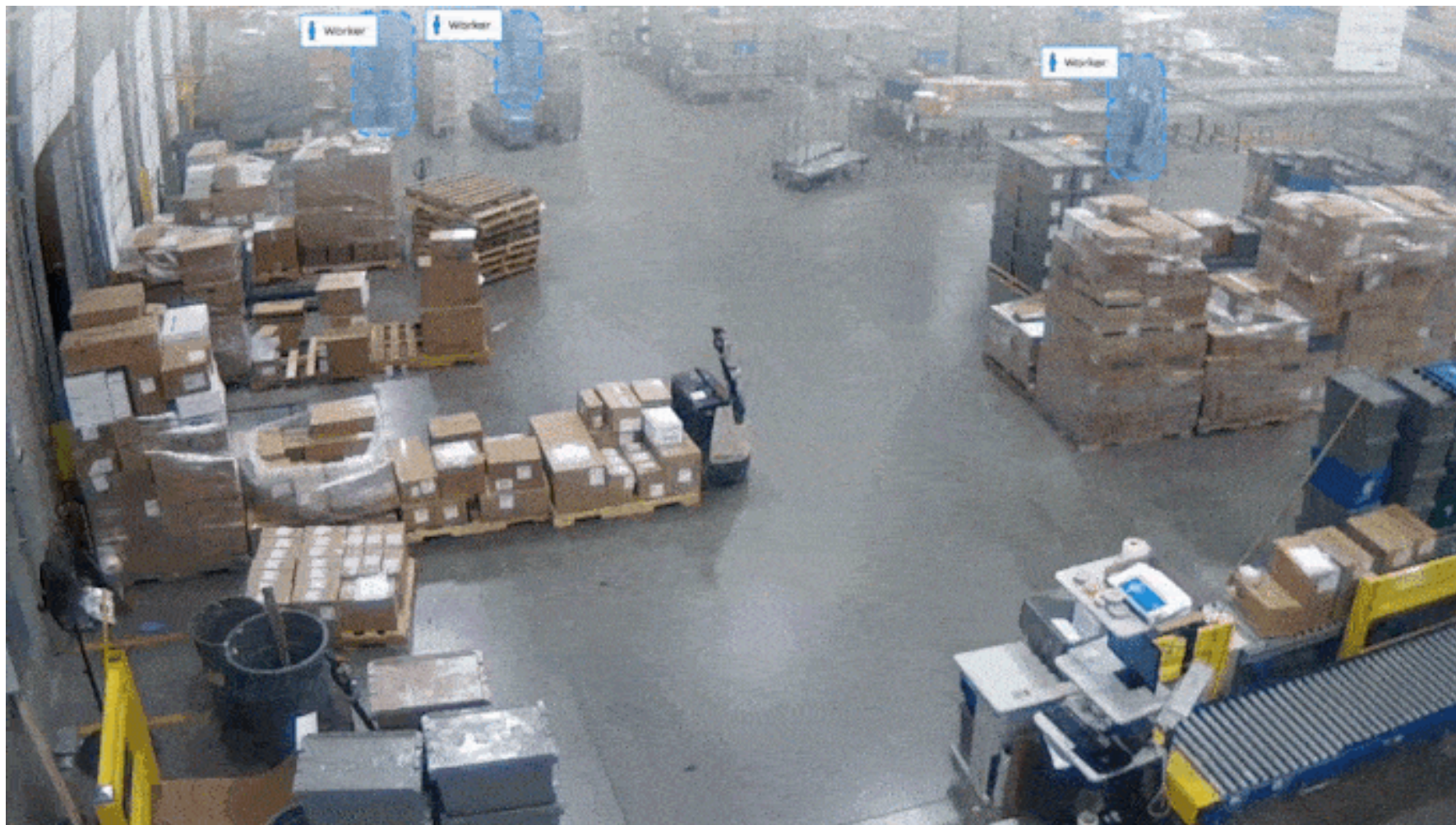


Multi-object Tracking





Multi-object Tracking





Challenges

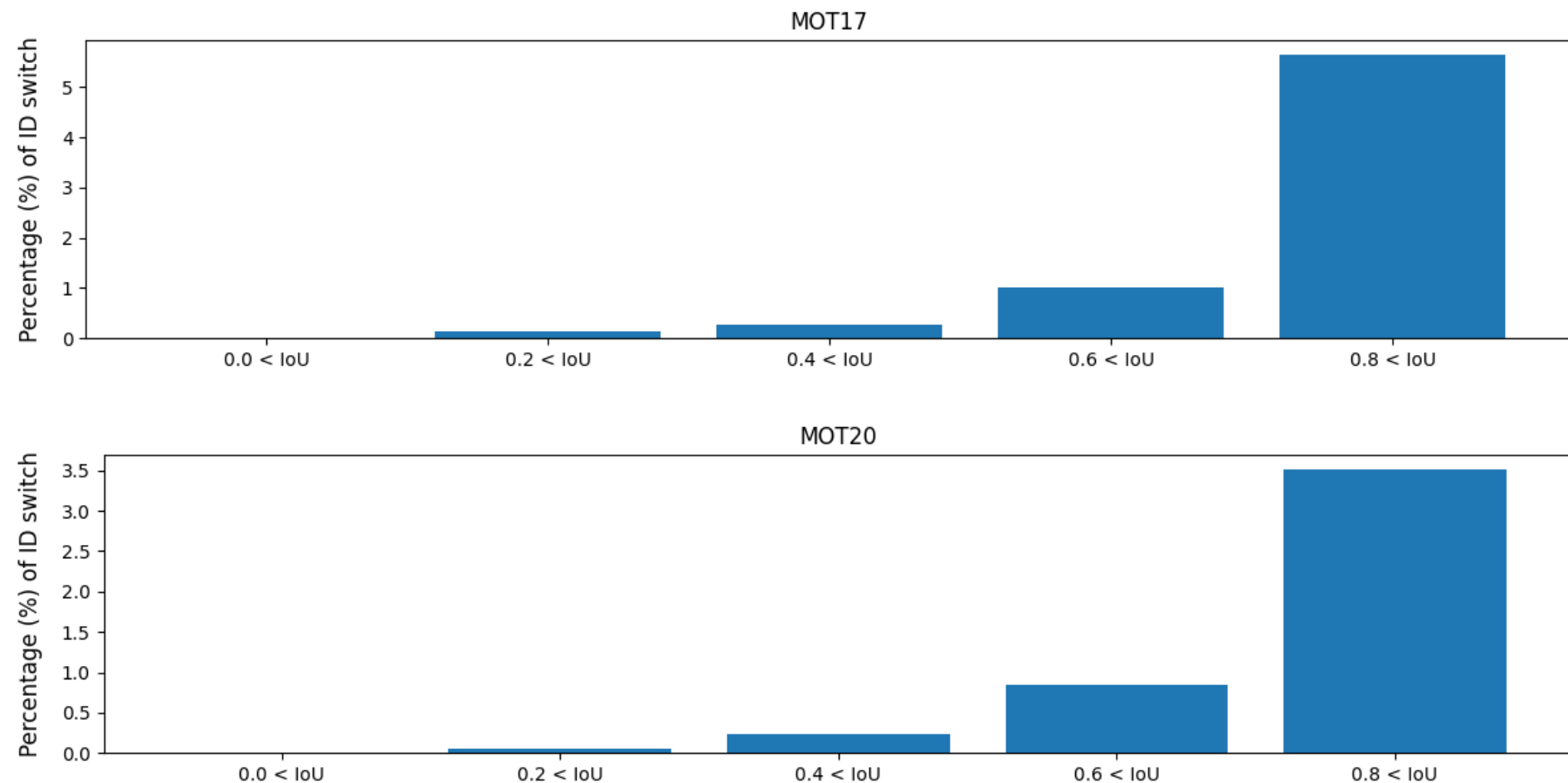
- Occlusion can make detector to miss objects and cause ID changes
- It is critical factor for the performance degradation in MOT





Comments from Proposals

- Effect of occlusions on ID change



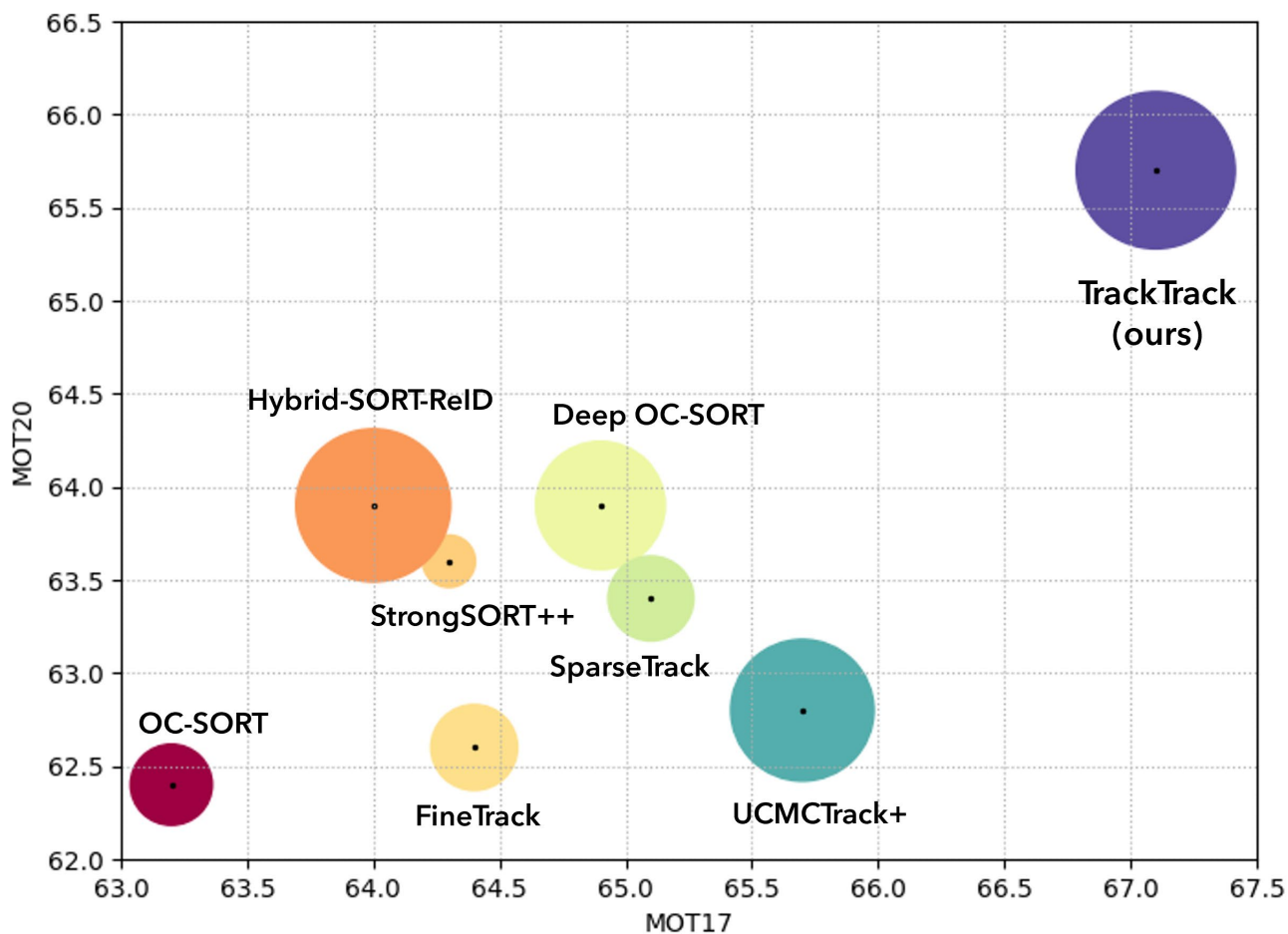


Method



TrackTrack

- **Track**-Focused Online Multi-Object **Tracker** (TrackTrack)





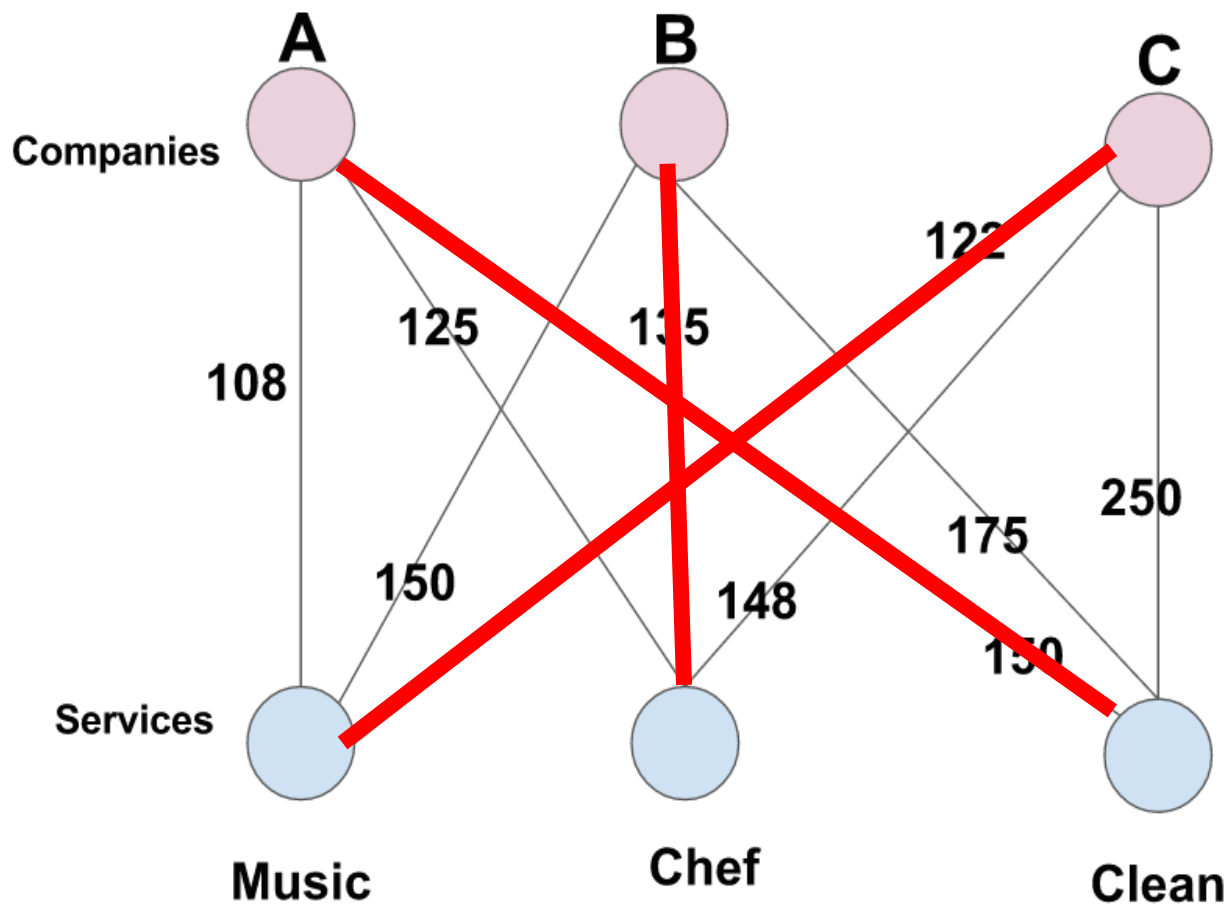
TrackTrack

- **Track-Perspective-Based Association (TPA)**
 - **Assignment:** We prioritize local matching precision
 - **Association Stage:** We association through joint and single stage scheme
- **Track-Aware Initialization**
 - **Track Initialization:** We exclude detection results that significantly overlap with active tracks and other more confident detection results



Assignment

- Hungarian Algorithm

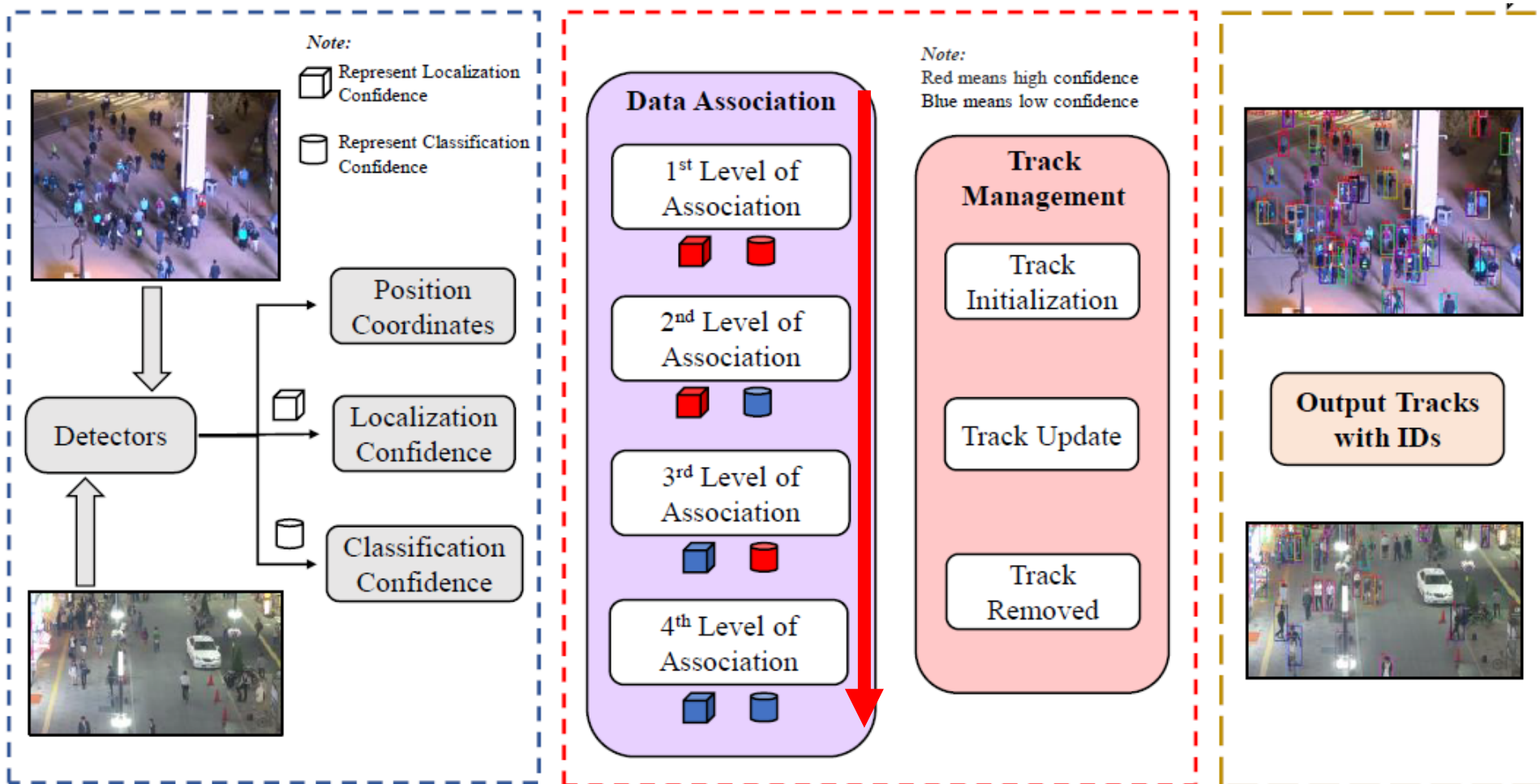


Assignment

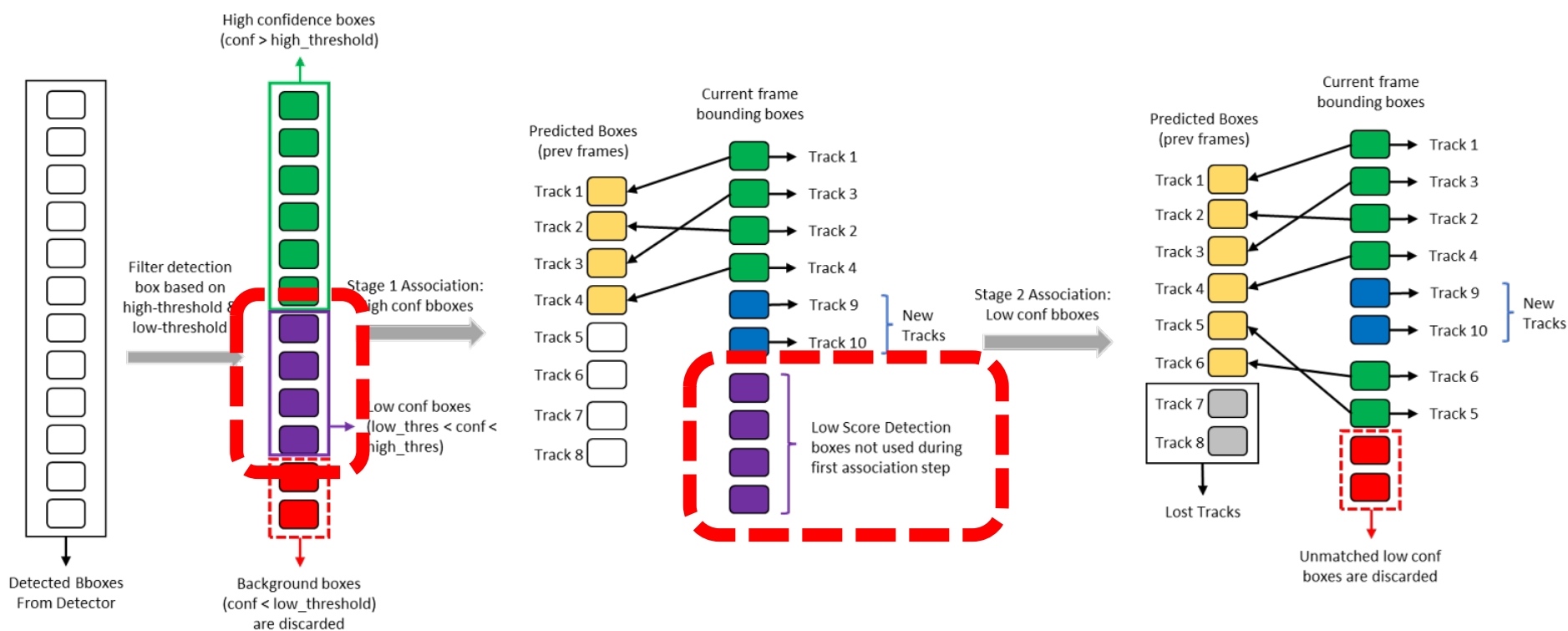
- Hungarian Algorithm



Association Stage

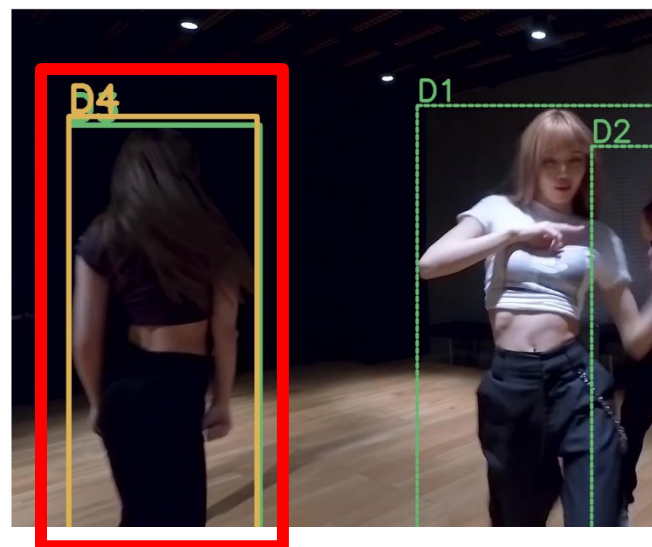
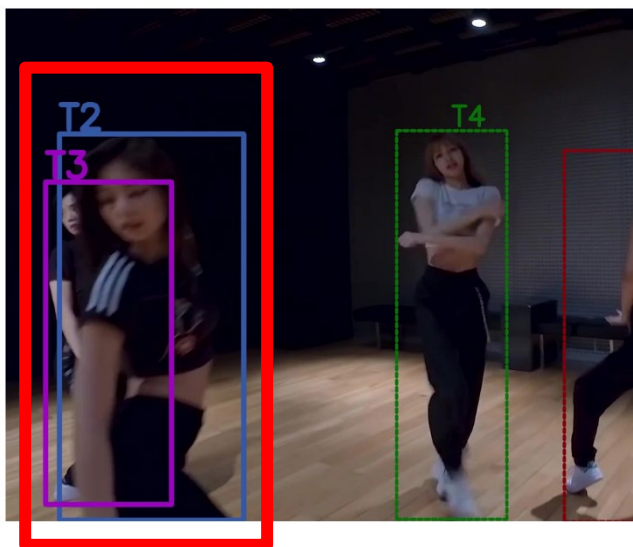


Association Stage





Association Stage





Track-Perspective-Based Association

- D_{high} : High-confidence detection results
- D_{low} : Low-confidence detection results
- D_{del_high} : High-confidence deleted detection results by NMS

$$C_{ij} = \begin{cases} d(T_i, d_j), & d_j \in \mathcal{D}_{high} \\ d(T_i, d_j) + \tau_p, & d_j \in \mathcal{D}_{low} \\ d(T_i, d_j) + \tau_q, & d_j \in \mathcal{D}_{del_high} \end{cases}$$



Track-Perspective-Based Association

- Match

$$\mathcal{M} = \{(T_i, d_j) | T_i = \arg \min_{T_l \in \mathcal{T}} C_{lj}, d_j = \arg \min_{d_k \in \mathcal{D}} C_{ik}, C_{ij} < \tau_m\},$$

- Exclude matched pairs

$$\mathcal{T}' = \mathcal{T} \setminus \{T_i \mid (T_i, d) \in \mathcal{M}\}$$

$$\mathcal{D}' = \mathcal{D} \setminus \{d_j \mid (T, d_j) \in \mathcal{M}\}$$

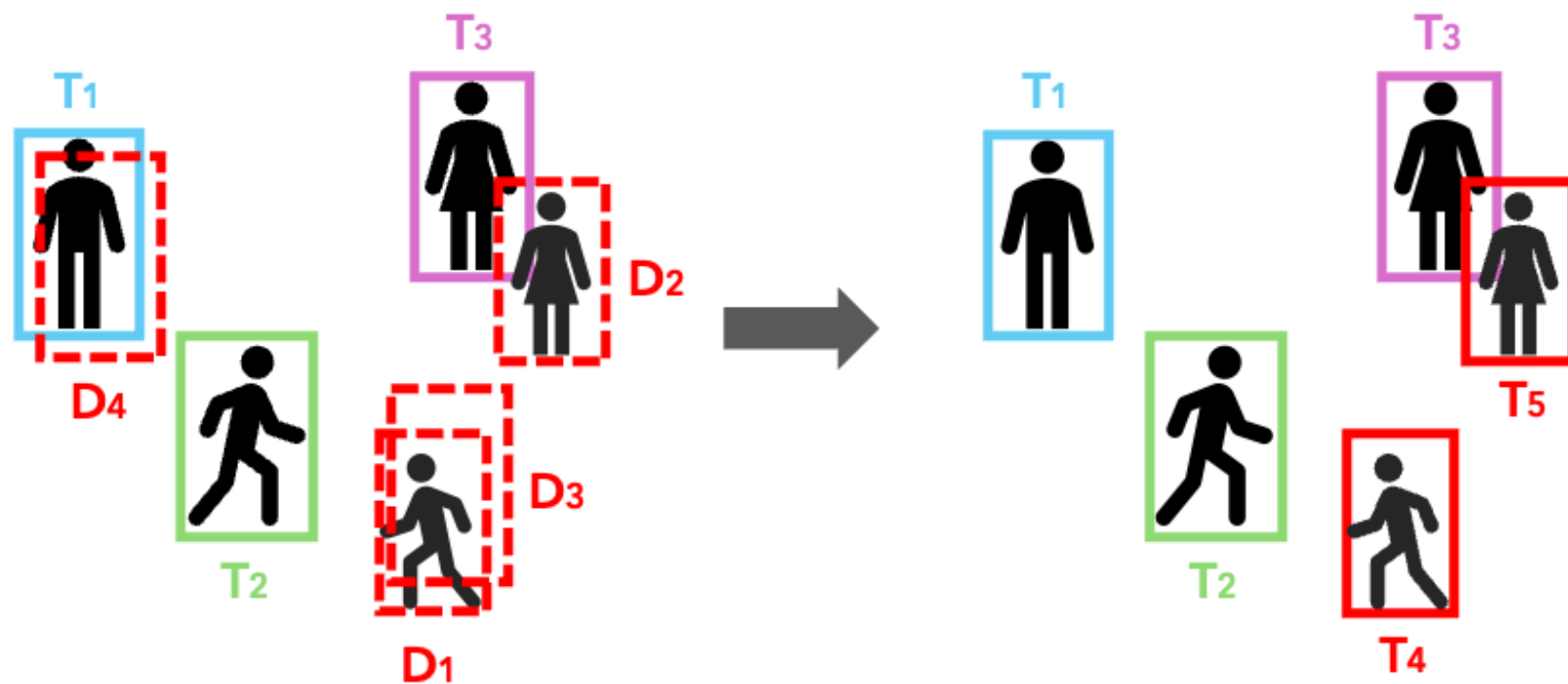


Track-Aware Initialization





Track-Aware Initialization





Experiments



Datasets

- **MOT17**
 - Seven sequences each for training and testing
 - Recorded in unconstrained environments





Datasets

- **MOT20**
 - Four videos for each training and testing
 - Highly crowded scenes





Datasets

- **DanceTrack**
 - 100 group dance videos
 - 40 training videos, 25 validation videos, and 35 test videos





Quantitative Results

MOT17					MOT20				
Tracker	HOTA↑	IDF1↑	MOTA↑	AssA↑	Tracker	HOTA↑	IDF1↑	MOTA↑	AssA↑
<i>Offline-Based</i>					<i>Offline-Based</i>				
SUSHI [7]	66.5	83.1	81.1	67.8	SUSHI [7]	64.3	79.8	74.3	67.5
CoNo-Link [13]	67.1	83.7	82.7	67.8	CoNo-Link [13]	65.9	81.8	77.5	68.0
<i>Online-Based</i>					<i>Online-Based</i>				
Hybrid-SORT-ReID [51]	64.0	78.7	79.9	63.5	StrongSORT++ [11]	62.6	77.0	73.8	64.0
FineTrack [32]	64.3	79.5	80.0	64.5	UCMCTrack+ [52]	62.8	77.4	75.6	63.5
StongSORT++ [11]	64.4	79.5	79.6	64.4	DeconfuseTrack [17]	63.3	77.6	78.1	62.7
Deep OC-SORT [26]	64.9	80.6	79.4	65.9	DATrack [27]	63.4	77.4	77.8	62.9
DeconfuseTrack [17]	64.9	80.6	80.4	65.1	SparseTrack [24]	63.4	77.3	78.2	62.8
SparseTrack [24]	65.1	80.1	81.0	65.1	FineTrack [32]	63.6	79.0	77.9	63.8
DATrack [27]	65.4	80.4	81.4	65.4	Deep OC-SORT [26]	63.9	79.2	75.6	65.7
CMTrack [40]	65.5	81.5	80.7	66.1	Hybrid-SORT-ReID [51]	63.9	78.4	76.7	64.5
AdapTrack [41]	65.7	82.3	79.9	66.9	ImprAsso [42]	64.6	78.8	78.6	64.6
UCMCTrack+ [52]	65.7	81.0	80.6	66.4	PIA [43]	64.7	79.0	78.5	64.9
PIA [43]	66.0	81.1	82.2	65.8	CMTrack [40]	64.8	79.9	76.2	66.7
ImprAsso [42]	66.4	82.1	82.2	66.6	AdapTrack [41]	65.0	80.7	75.0	67.8
TrackTrack (Ours)	67.1	83.1	81.8	68.2	TrackTrack (Ours)	65.7	80.9	78.0	67.3

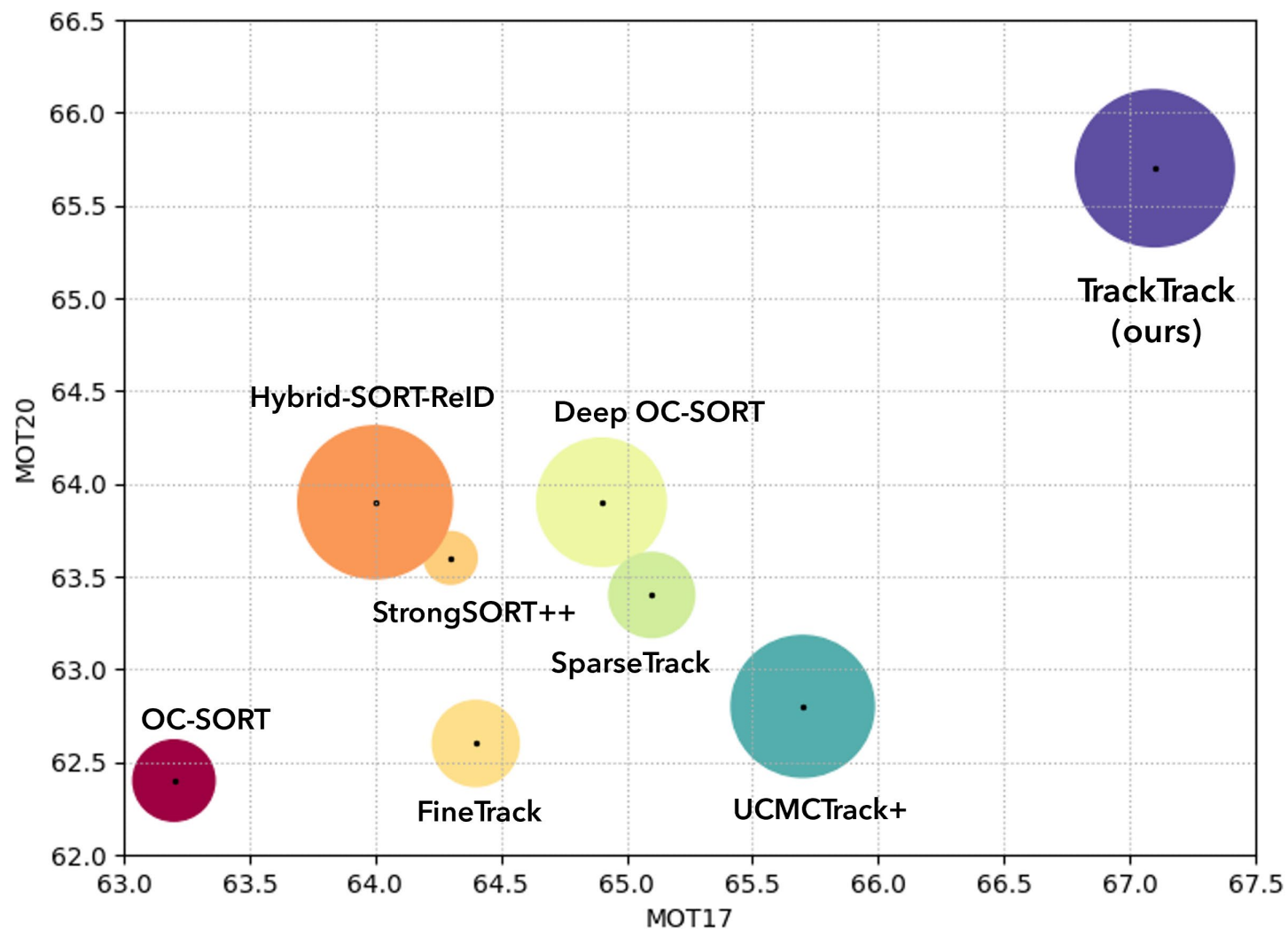


Quantitative Results

DanceTrack				
Tracker	HOTA↑	IDF1↑	MOTA↑	AssA↑
<i>Offline-Based</i>				
SUSHI [7]	63.3	63.4	88.7	50.1
CoNo-Link [13]	63.8	64.1	89.7	50.7
<i>Online-Based</i>				
FineTrack [32]	52.7	59.8	89.9	38.5
OC-SORT [6]	55.1	54.6	92.0	38.3
SparseTrack [24]	55.5	58.3	91.3	39.1
StrongSORT++ [11]	55.6	55.2	91.1	38.6
GHOST [38]	56.7	57.7	91.3	39.8
CBIoU [50]	60.6	61.6	91.6	45.4
Deep OC-SORT [26]	61.3	61.5	92.3	45.8
CMTrack [40]	61.8	63.3	92.5	46.4
UCMCTrack+ [52]	63.6	65.0	88.9	51.3
Hybrid-SORT-ReID [51]	65.7	67.4	91.8	-
TrackTrack (Ours)	66.5	67.8	93.6	52.9

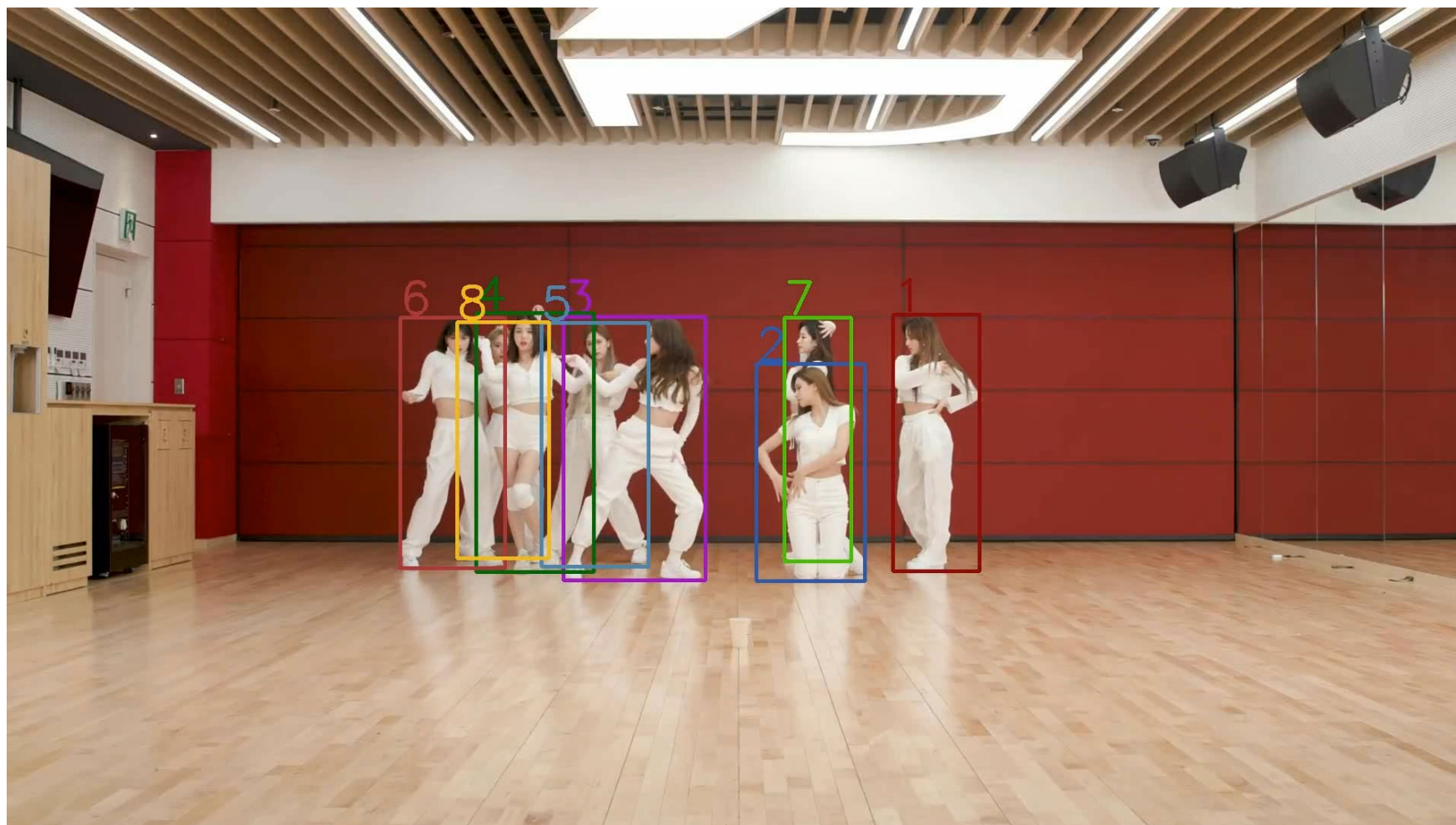


Quantitative Results



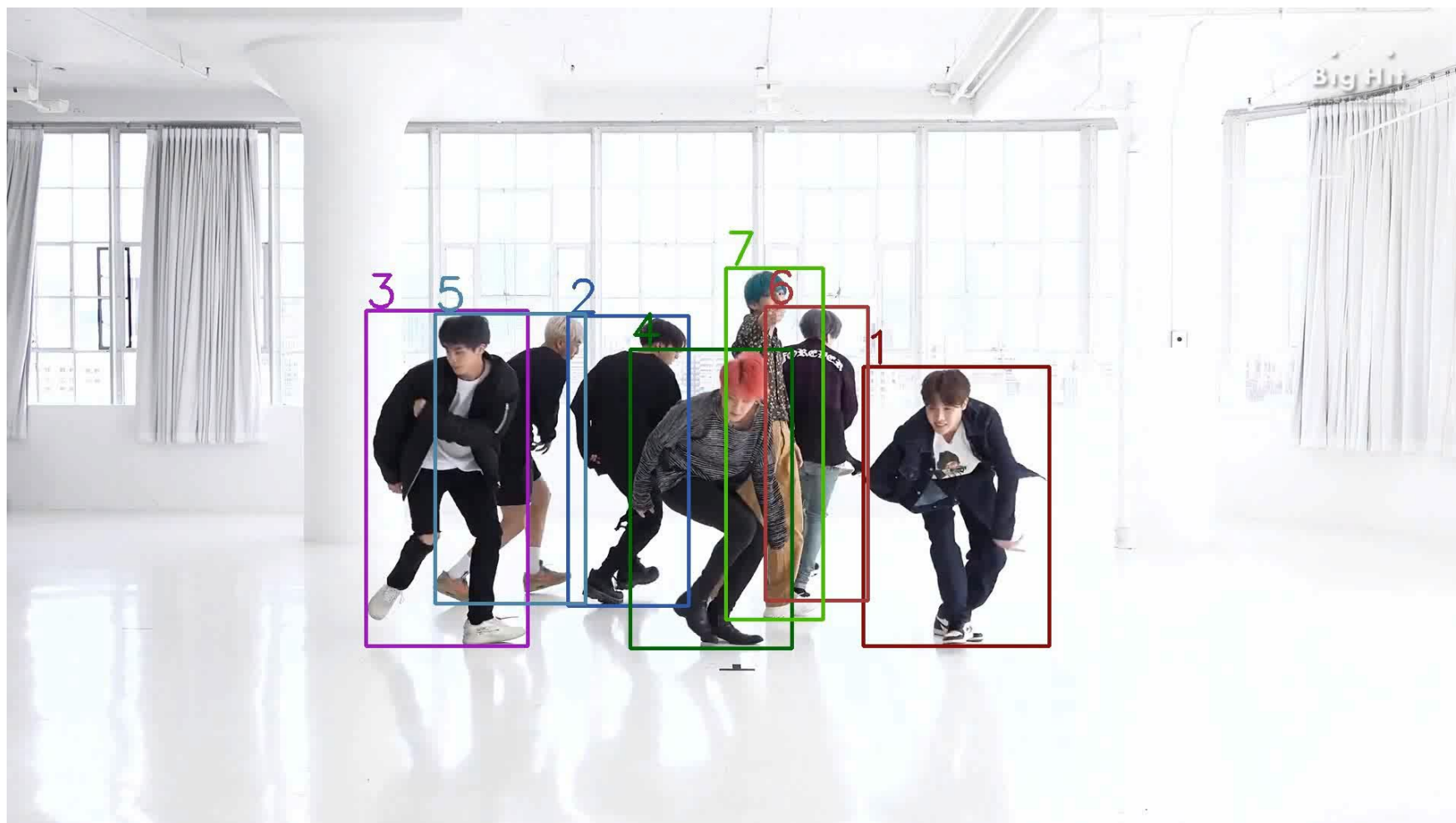


Qualitative Results



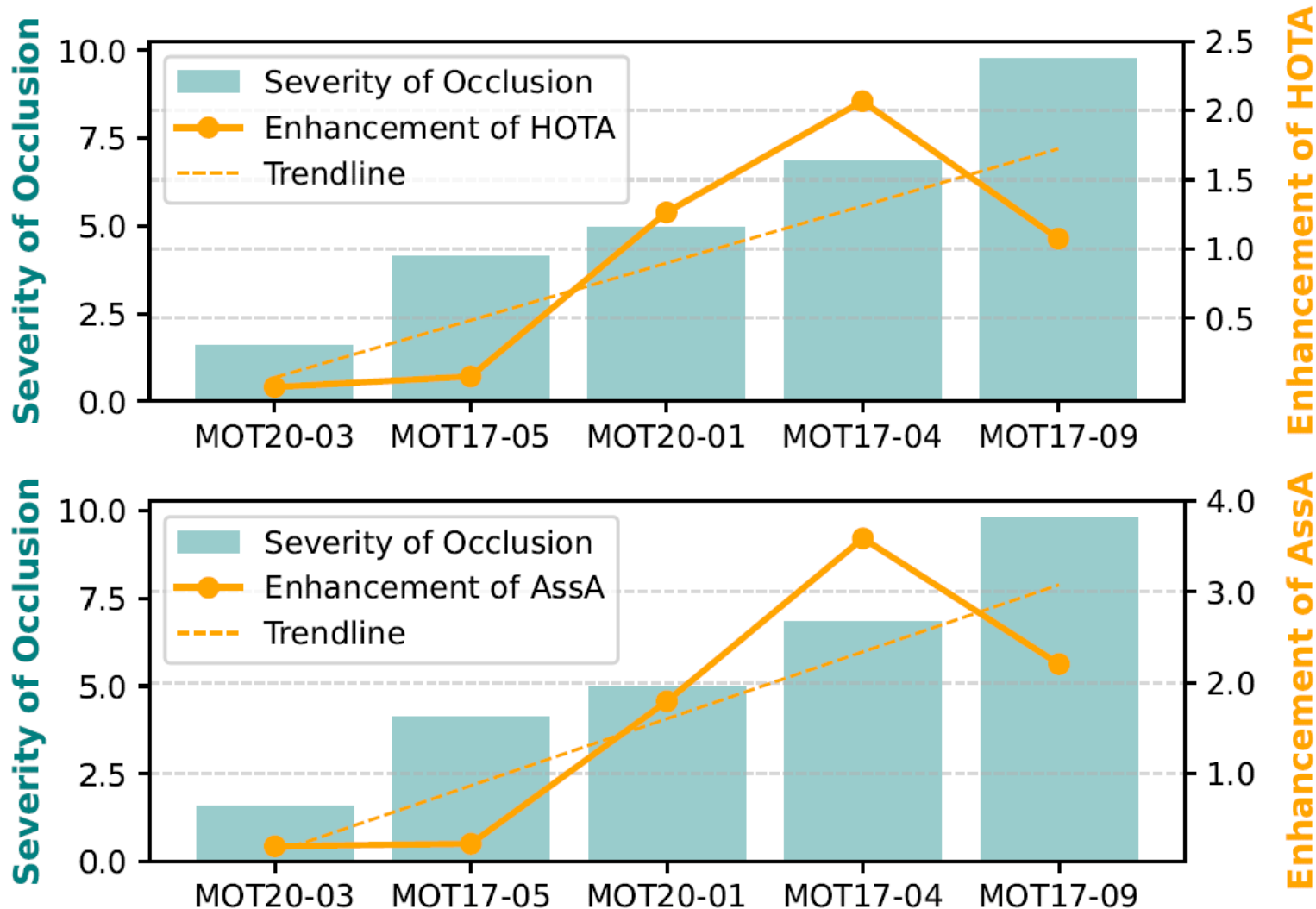


Qualitative Results





Effectiveness Under Occlusion Conditions





Thank you