ECCV DeeperAction Challenge

SportsMOT Track on Multi-actor Tracking

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Track 3, DeeperAction, ECCV 2022

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Outline

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Part 1: Motivation

Part 2: SportsMOT Dataset

Part 3: SportsMOT Challenge

Part 1: Motivation

Motivation: MOT

- **Multi-Object Tracking**
  - Foundational task for high-level action recognition

- **Input: Video**
- **Output: Tracks (Bounding Boxes & IDs)**

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MOT Benchmarks

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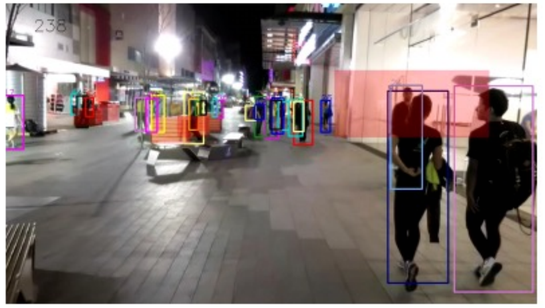
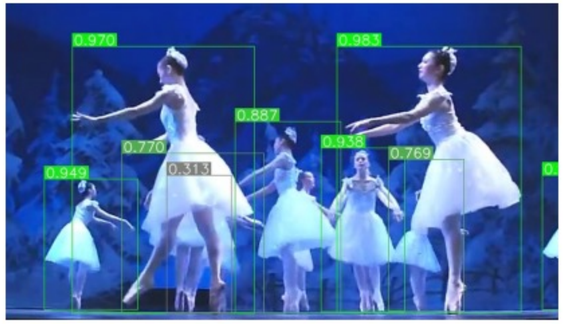
• MOT Challenge[1][2]



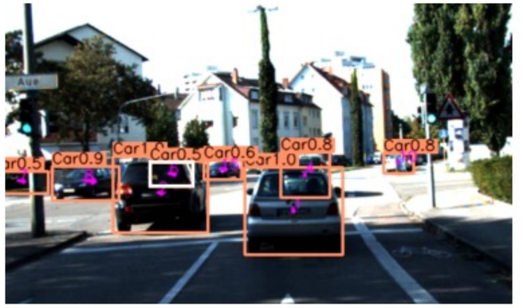
- Pedestrians
- Varying scales
- Simple motion
- Few videos

• DanceTrack[3]



- Dancers
- Nearly static camera
- Uniform appearance
- Complex motion

• KITTI[4]



- Pedestrians & Vehicles
- Driving scenes
- Limited motion
- Stereo & laser information

[1] MILAN A, LEAL-TAIXÉ L, REID I, et al. MOT16: A benchmark for multiobject tracking[J]. arXiv preprint arXiv:1603.00831, 2016.
[2] DENDORFER P, REZATOFIGHI H, MILAN A, et al. Mot20: A benchmark for multi object tracking in crowded scenes[J]. arXiv preprint arXiv:2003.09003, 2020.
[3] SUN P, CAO J, JIANG Y, et al. DanceTrack: Multi-Object Tracking in Uniform Appearance and Diverse Motion[J]. arXiv preprint arXiv:2111.14690, 2021.
[4] GEIGER A, LENZ P, URTASUN R. Are we ready for autonomous driving? the kitti vision benchmark suite[C]//2012 IEEE conference on computer vision and pattern recognition. 2012: 3354-3361.

Motivation

- **Applications**
  - MOT in sports scenes
  - Sports scenarios: player tracking, strategy analysis, etc.
- **Focus: Tracking in Sports Scenes**
  - Visually comfusable
  - Complex motion
  - Fine annotations
- **Encourage the Community**
  - Concentrate more on the complicated sports scenes

Part 2: SportsMOT Dataset

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SportsMOT Dataset

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- **A Large-Scale Multi-Object Tracking Dataset in Sports Scenes**

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Data Annotation

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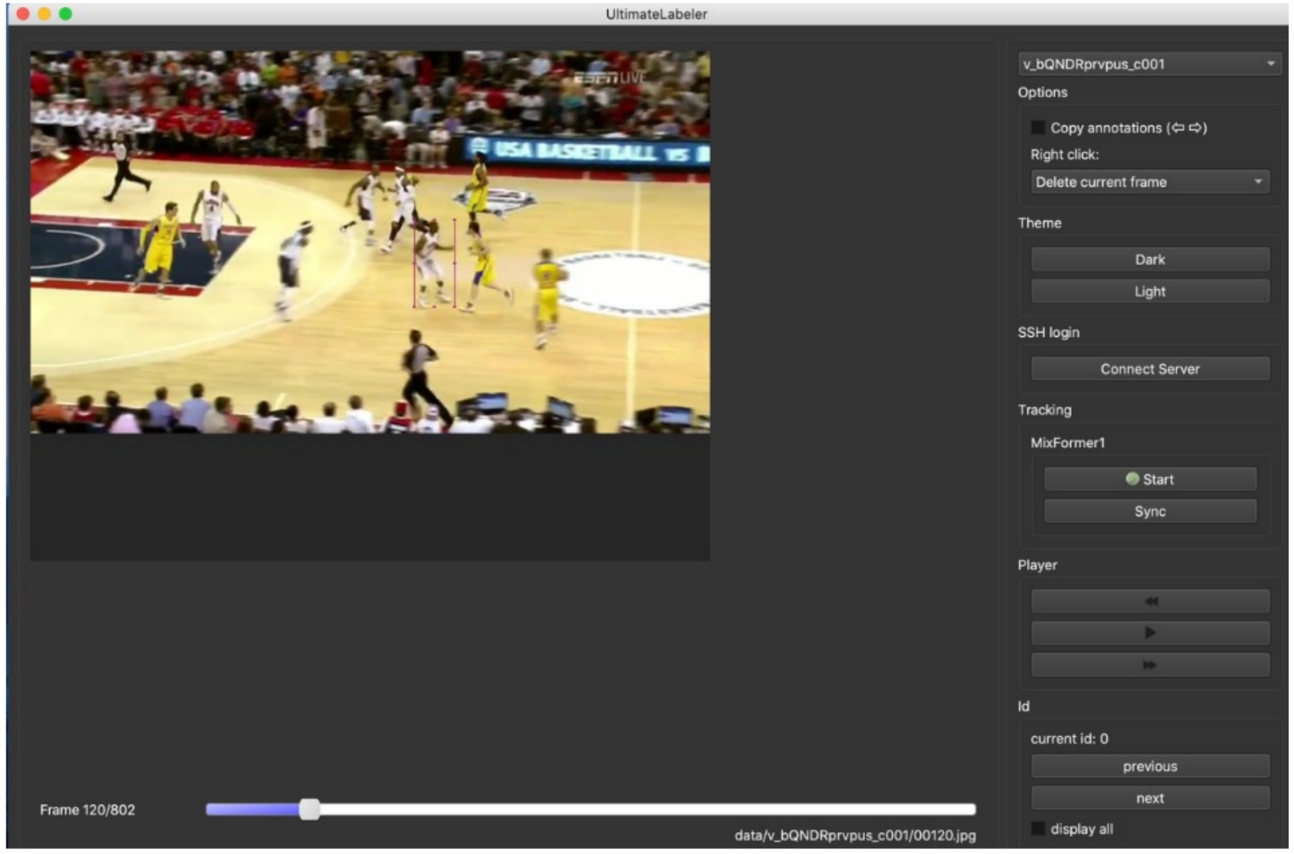
- **Collect Videos**
  - No shooting switch
  - Camera angle and position change
- **Fine Annotations**
  - KCF-based labeling tool
- **Manual Check**
  - Bounding box accurary
  - Consistent ID



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Overview

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- **Features**
  - ***1.6M+*** bounding boxes in different sports scenes
    - Total #frames ≈ MOT20 > DanceTrack/ MOT17
  - High resolution(1280*720) & High FPS(25)
  - Confusable appearance
  - Complex motion

Dataset	Videos	Total len.(s)	Avg. len.(s)	Tracks	Images	Bounding boxes
MOT17	14	463	35.4	1342	11235	292733
MOT20	8	535	**66.8**	**3456**	13410	**1652040**
DanceTrack	100	5292	52.9	990	105855	-
SportsMOT	**240**	**6015**	25.1	3401	**150379**	1629490

SportsMOT	Avg
#Frames	626.6
#Tracks	14.2
Track gap length	96.6
Track length	479.1
#Bboxes per frame	10.8

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Analysis: Appearance

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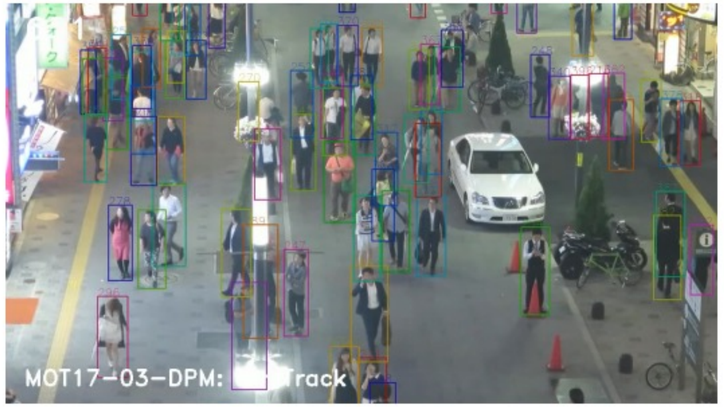
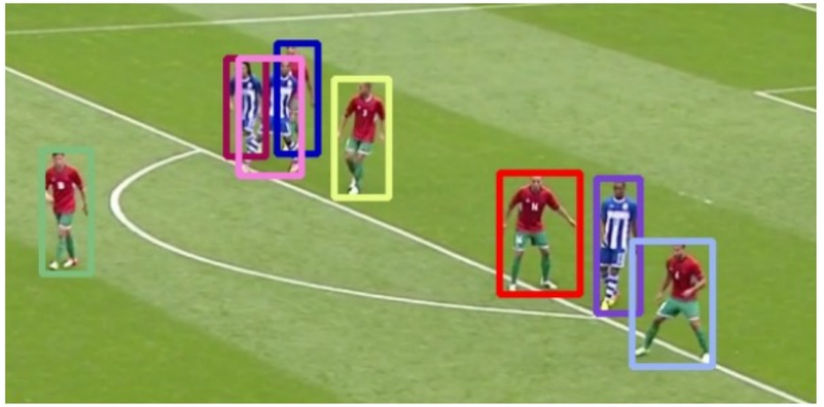
- **Re-Identification Feature Space**





MOT 17

SportsMOT

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Analysis: Motion

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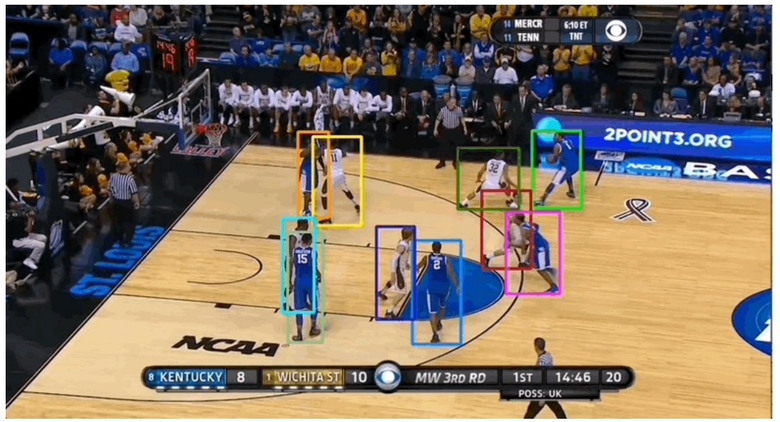
- **Diverse Speed Distribution**
  - Non-uniform speed
  - Significant variation

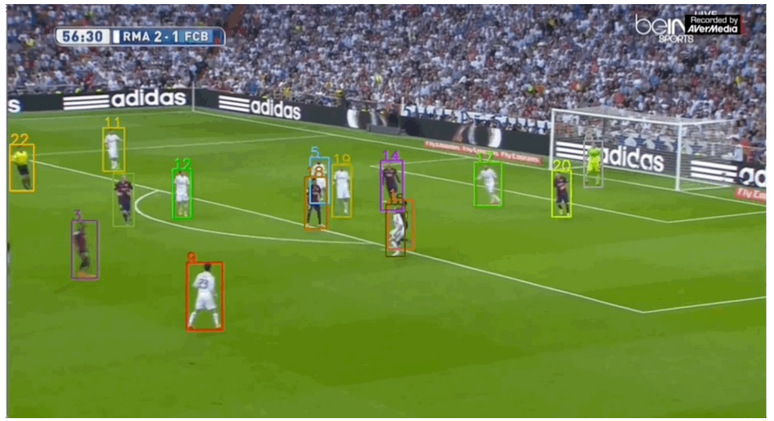
	Basketball	Volleyball	Football
Avg. speed	6.15	9.31	6.64
Std. speed	2.39	5.58	3.91

- **Severe Articulation**

$$\text{deformationRate}(\mathbf{b}_i) = \frac{w_{max} - w_i}{w_{min}} + \frac{h_{max} - h_i}{h_{min}}$$

Category	Basketball	Volleyball	Football	Total avg.
Avg. def. rate	2.17	1.68	2.62	2.26





- **Complex Motion Patterns**
  - Discourage strong motion prior
  - Encourage adaptive motion modeling

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Easy Cases

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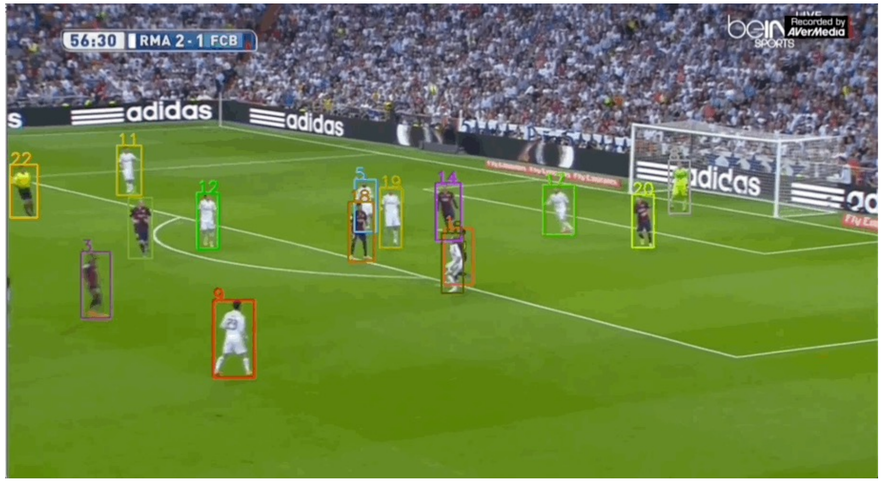

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Hard Cases

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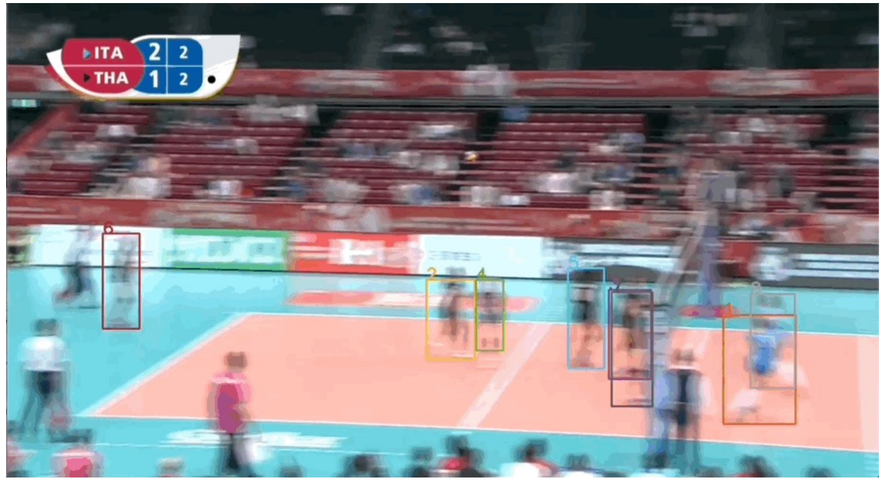

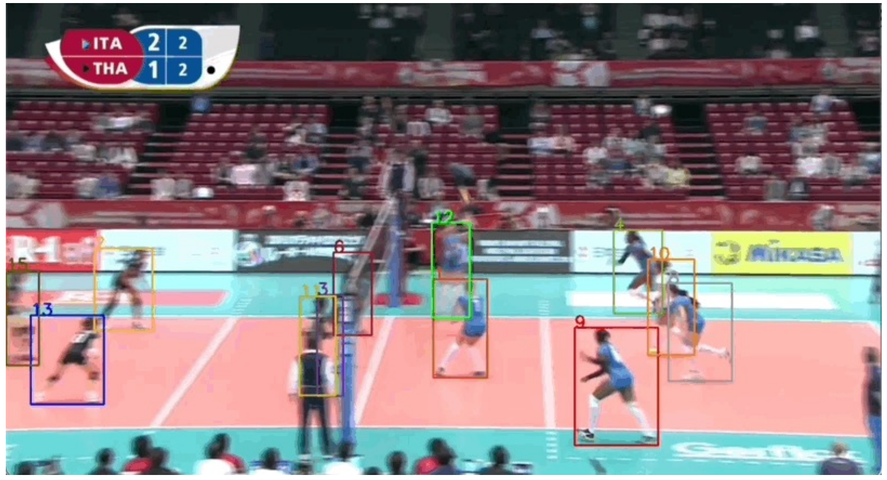

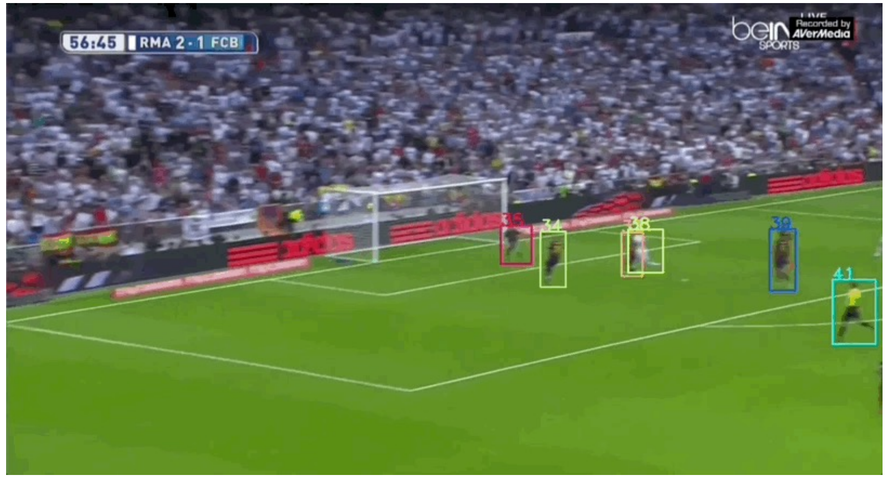

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Common Errors

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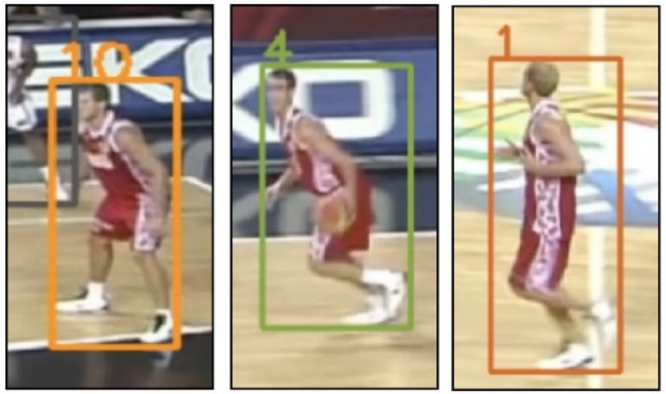
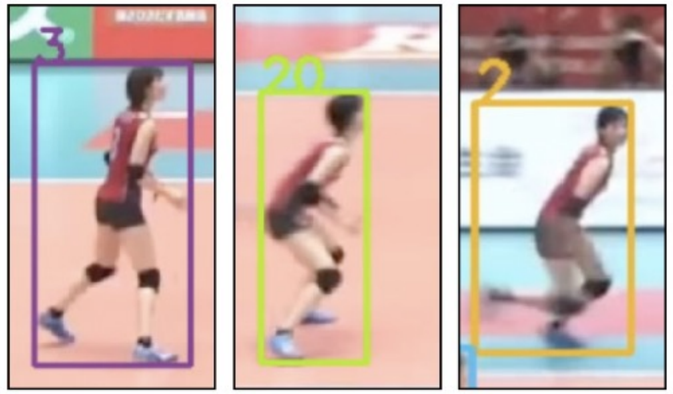
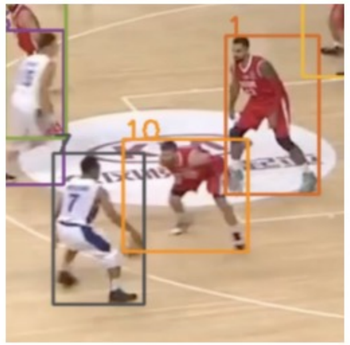




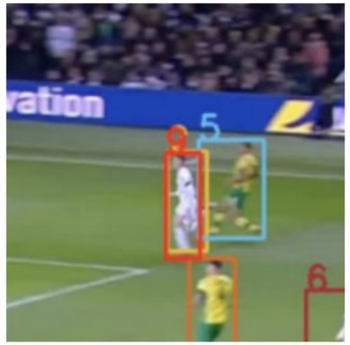
Similar appearance



Inaccurate bbox

Missed detection

ID switch



Duplicate bboxes

False detection

Part 3: SportsMOT Challenge

Metrics

- **HOTA**[5]
  - DetA: detection accuracy
  - AssA: association accuracy
- **MOTA**[6]
- **Identity-based**[7]
  - IDF1
  - IDs
  - Frag

$$\mathrm{DetA}_\alpha = \frac{|\mathrm{TP}|}{|\mathrm{TP}| + |\mathrm{FN}| + |\mathrm{FP}|},$$

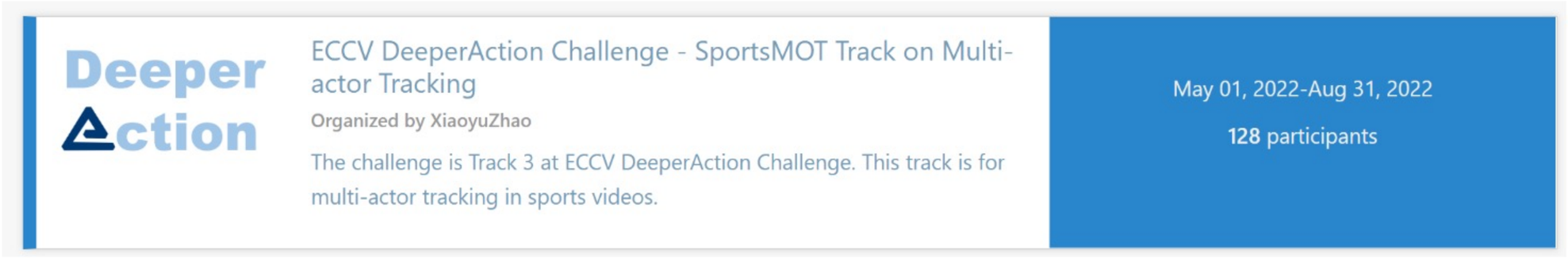
$$\mathrm{AssA}_\alpha = \frac{1}{|\mathrm{TP}|} \sum_{c \in \{\mathrm{TP}\}} \mathcal{A}(c),$$

$$\mathcal{A}(c) = \frac{|\,\mathrm{TPA}(c)|}{|\,\mathrm{TPA}(c)| + |\,\mathrm{FNA}(c)| + |\,\mathrm{FPA}(c)|}.$$

$$\mathrm{HOTA}_\alpha = \sqrt{\frac{\sum_{c \in \{\mathrm{TP}\}} \mathcal{A}(c)}{|\mathrm{TP}| + |\mathrm{FN}| + |\mathrm{FP}|}} = \sqrt{\mathrm{DetA}_\alpha \cdot \mathrm{AssA}_\alpha}.$$

[5] LUITEN J, OSEP A, DENDORFER P, et al. Hota: A higher order metric for evaluating multi-object tracking[J]. International journal of computer vision, 2021, 129(2): 548-578.
[6] K. Bernardin and R. Stiefelhagen, “Evaluating Multiple Object Tracking Performance: The CLEAR MOT Metrics,” EURASIP Journal on Image and Video Processing, vol. 2008, pp. 1–10, 2008, doi: 10.1155/2008/246309.
[7] E. Ristani et al., “Performance Measures and a Data Set for Multi-Target, Multi-Camera Tracking,” arXiv:1609.01775 [cs], Sep. 2016, Accessed: Apr. 12, 2022. [Online].

SporsMOT Challenge



- **Valid participants**
  - 129
  - Industry, academia

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SporsMOT Challenge

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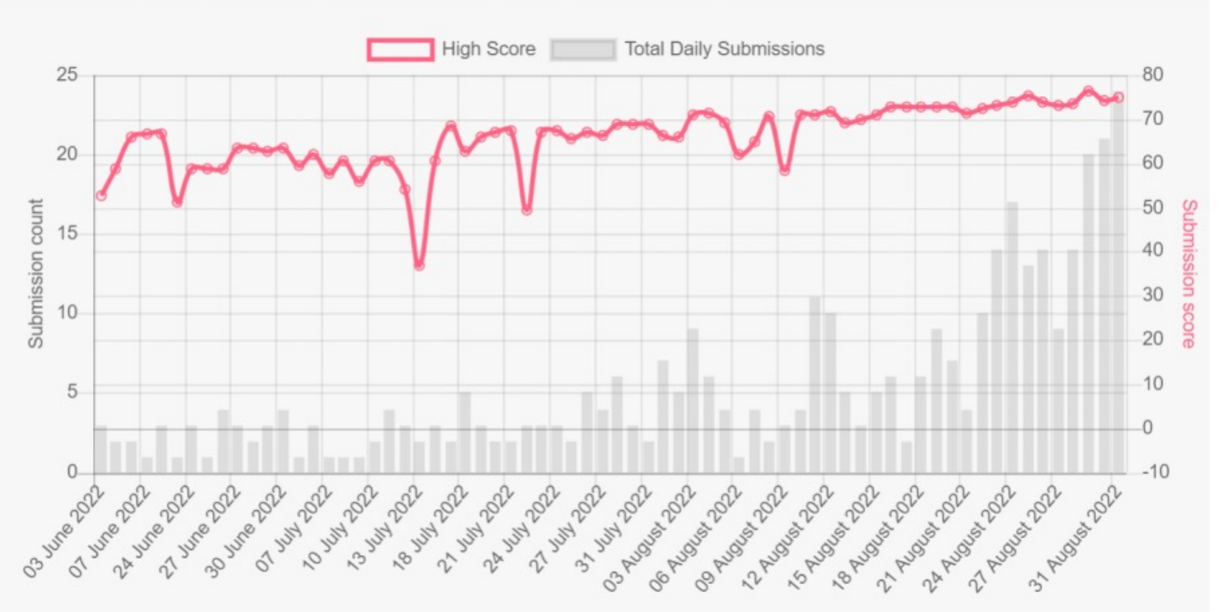
- **Development**
  - 228 submissions
- **Test**
  - 210 submissions



Test Set of SportsMOT (Ranked by HOTA)

#	User	Entries	Date of Last Entry	Team Name	HOTA ▲	AssA ▲	DetA ▲	MOTA ▲	IDF1 ▲	IDs ▲	Frag ▲
1	BOE_AIoT_CTO	8	08/29/22	BOE_AIoT_CTO	76.264 (1)	73.538 (1)	79.180 (6)	89.316 (8)	84.453 (1)	2567.0 (1)	6104.0 (5)
2	PingPingPangPangBangBangBang	16	08/31/22	IPIU	74.899 (2)	64.592 (2)	86.968 (2)	95.590 (2)	78.342 (2)	4853.0 (6)	4536.0 (4)
3	hsiangwei0903	10	08/31/22	UWIPL_ETRI	73.968 (3)	63.460 (3)	86.316 (3)	94.832 (3)	78.271 (3)	2754.0 (2)	3592.0 (1)

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1st Place Winner

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SportsTrack

Jie Wang*, Xiaodong Yang, Pengyu Zhou, Ting Wang, Yanming Zhang
BOE AIoT CTO
**Corresponding to: bluetornado@zju.edu.cn*

BOE

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2nd Place Winner

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A Technical Report for SportsMOT Track on Multi-actor Tracking

Jiahao Wang*, Chang Meng, Donghao Li, Hao Wang, Yuting Yang, Licheng Jiao, Fang Liu

School of Artificial Intelligence, Xidian University

*Corresponding to: jh_wang1024@163.com

西安電子科技大學

XIDIAN UNIVERSITY

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3rd Place Winner

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Observation Centric and Central Distance Recovery on Sports Player Tracking

Hsiang-Wei Huang, Cheng-Yen Yang, Jenq-Neng Hwang
Pyong-Kun Kim, Kwangju Kim, Kyoungoh Lee

University of Washington, Seattle
Electronics and Telecommunications Research Institute, Korea

UNIVERSITY of WASHINGTON

ETRI 한국전자통신연구원 Electronics and Telecommunications Research Institute

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Thanks!

Homepage: https://deeperaction.github.io/tracks/sportsmot

Github: https://github.com/MCG-NJU/SportsMOT