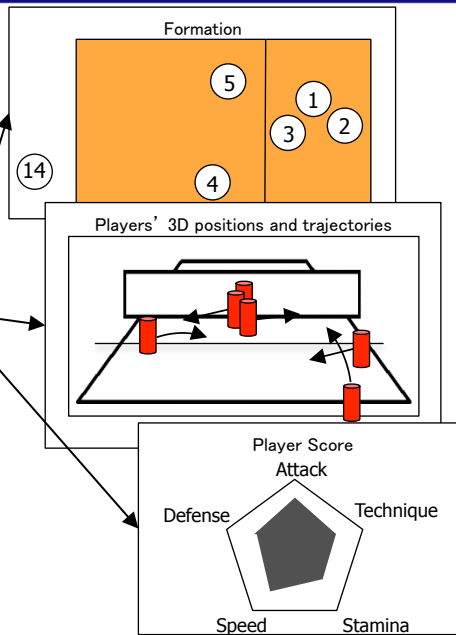# Particle Filter using Players Feature based Multi-Likelihood and 3D Elimination of Other Players for 3D Multiple Players Tracking in Volleyball

修士課程卒業　庄系舟

➤ Research background
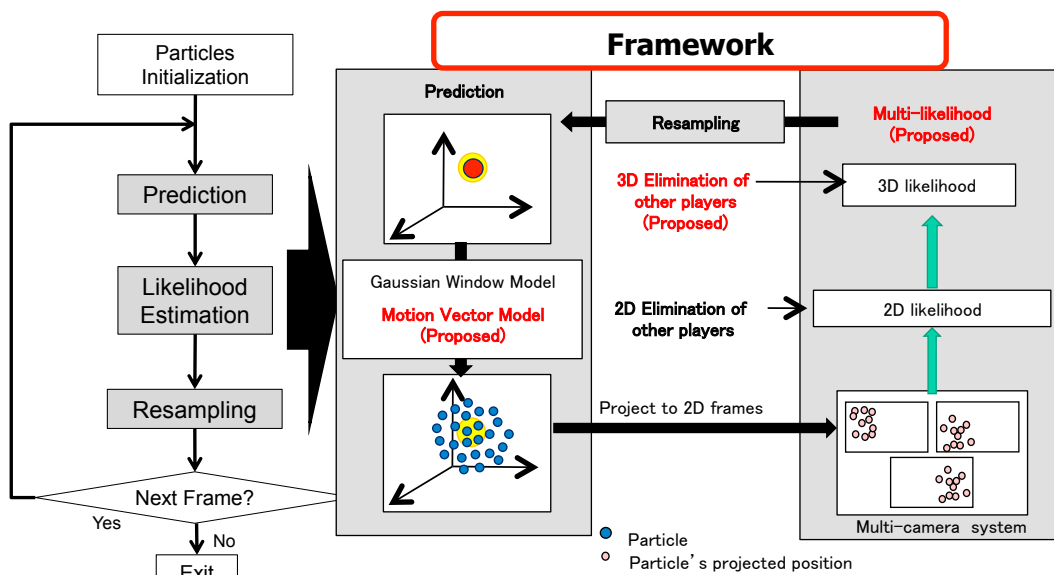
3D Multiple Players Tracking

Formation

Players' 3D positions and trajectories

Player Score

- Attack
- Technique
- Stamina
- Speed
- Defense

Problems and Solutions of Players Tracking

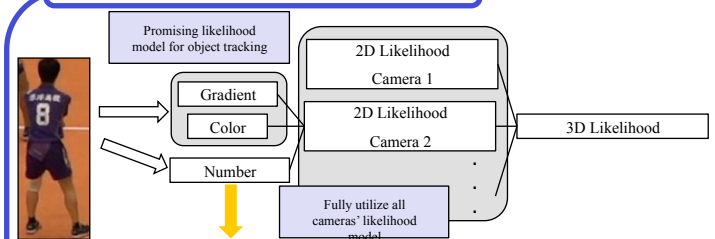|	Problems	Solutions
Size	Big	Particle Filter
Rigid or not	Non-rigid	
Speed	Slow	
Movement	Irregular	
Main disturbance	Occluded by other targets with similar features	Players Feature based Multi-Likelihood and 3D Elimination of Other Players
Target	Multiple	

Research Target
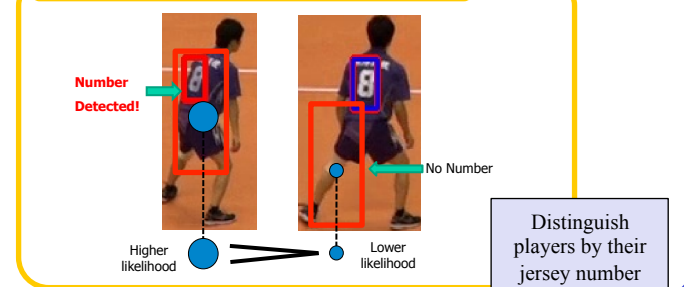
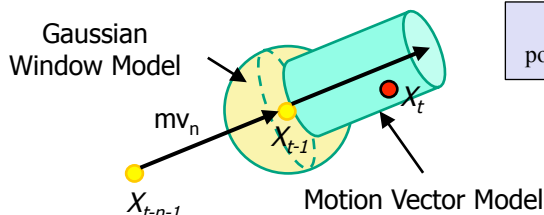Improve the accuracy of 3D players tracking algorithm.

➤ Proposed method

Framework

- Particles Initialization
- Prediction
- Likelihood Estimation
- Resampling
- Next Frame?
  - Yes
  - No → Exit

Prediction

Resampling

Multi-likelihood (Proposed)

3D Elimination of other players (Proposed)

3D likelihood

Gaussian Window Model
Motion Vector Model (Proposed)

2D Elimination of other players

2D likelihood

Project to 2D frames

Multi-camera system

● Particle
○ Particle's projected position

Multi-Likelihood Model

Promising likelihood model for object tracking

- Gradient
- Color
- Number

2D Likelihood Camera 1
2D Likelihood Camera 2

3D Likelihood

Fully utilize all cameras' likelihood model

Number Detection Likelihood Model

Number Detected!

No Number

Higher likelihood

Lower likelihood

Distinguish players by their jersey number

Motion Vector Prediction Model

Gaussian Window Model

mv_n

X_{t-n-1}

X_{t-1}

X_t

Motion Vector Model

Re-predict players position after occlusion.

3D Elimination of Other Players

Eliminate disturbance from other players

Target

➤ Experiment result:

	Before Occlusion	During Occlusion	After Occlusion
Proposal			Successful
Conventional Work			Failed
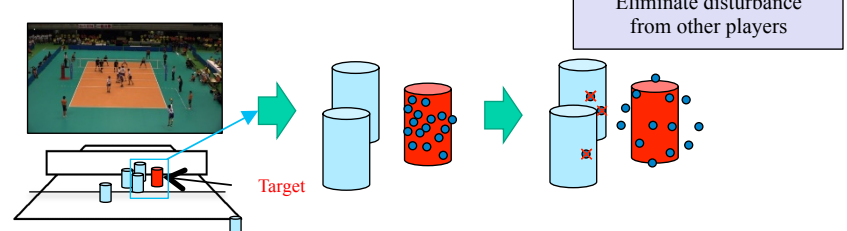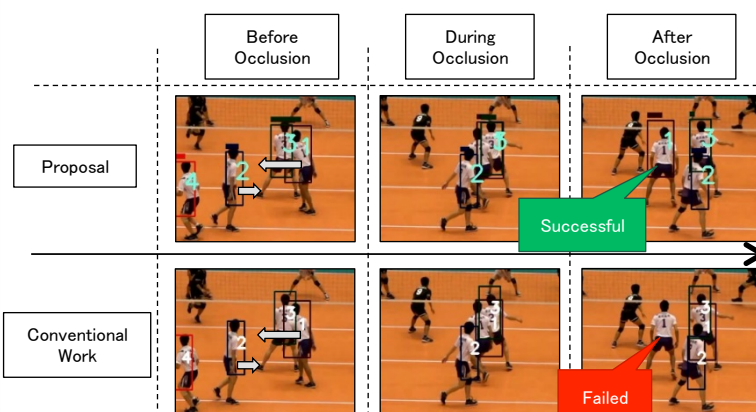
Success Rate Comparison in the First Set

Round	RU per Round	Proposal	Conventional work	Round	RU per Round	Proposal	Conventional work
1	18	16	12	19	6	6	5
2	12	12	8	20	6	6	5
3	6	6	4	21	6	6	6
4	6	6	2	22	12	11	10
5	6	6	6	23	6	6	6
6	12	10	10	24	6	6	4
7	6	6	6	25	12	12	7
8	24	23	23	26	42	39	39
9	18	18	16	27	6	5	5
10	12	11	12	28	12	12	11
11	6	6	5	29	6	6	4
12	6	6	6	30	6	6	6
13	18	18	15	31	6	6	6
14	12	10	9	32	6	6	5
15	18	18	18	33	6	5	5
16	6	6	5	Total	348	334	294
17	12	12	8	Success_Rate		96.0%	84.5%
18	6	6	5				

Overall Success Rate

	Proposal	Conventional work
First Set	96.0%	84.5%
Third Set	97.6%	88.6%
Execution time	24s/f	8s/f
Total	96.8%	86.6%

➤ Conclusion:

With the proposed particle filter based 3D multiple players tracking algorithm, averagely 96.0% and 97.6% success rate can be achieved in the first set and the third set.