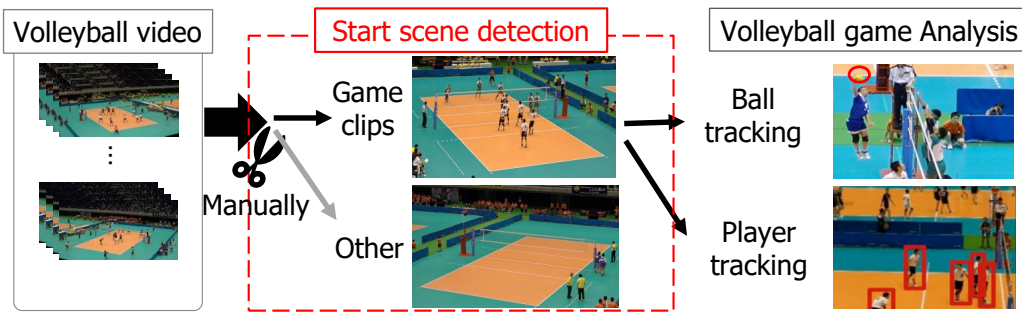# 3D Ball Motion and Relative Position Feature Based Start Scene Detection for 60fps Volleyball Game Analysis on GPU

修士課程卒業　梁貴鈃

➢ Background
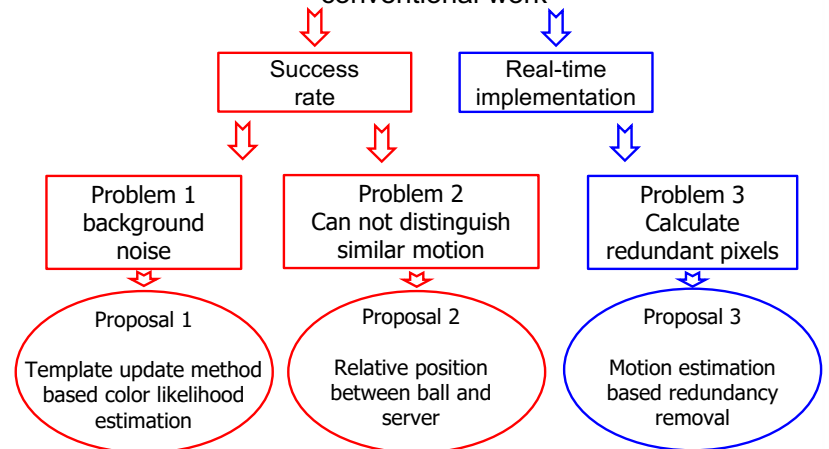
Volleyball video

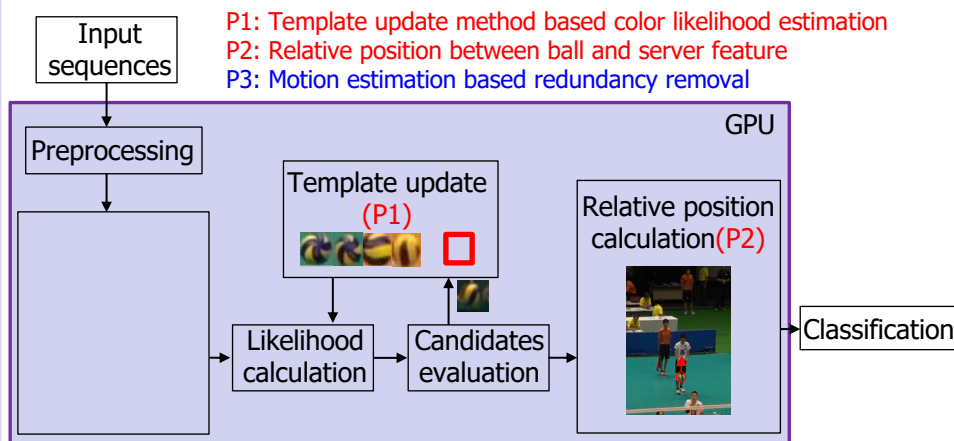Start scene detection
- Game clips
- Other

Manually

Volleyball game Analysis
- Ball tracking
- Player tracking

...

Demand for:

➢ **High success rate**　　➢ **Real-time**

Ball feature based start scene detection conventional work

| Success rate | Real-time implementation |

Problem 1 background noise

Problem 2 Can not distinguish similar motion

Problem 3 Calculate redundant pixels

Proposal 1 — Template update method based color likelihood estimation

Proposal 2 — Relative position between ball and server

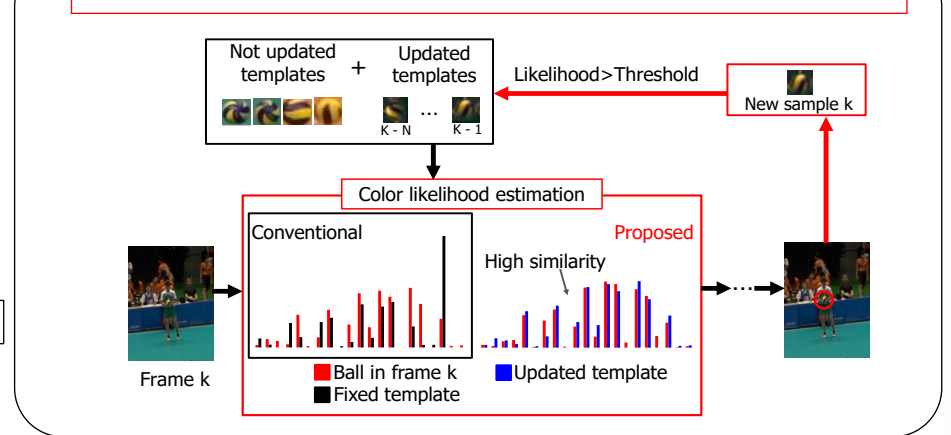Proposal 3 — Motion estimation based redundancy removal
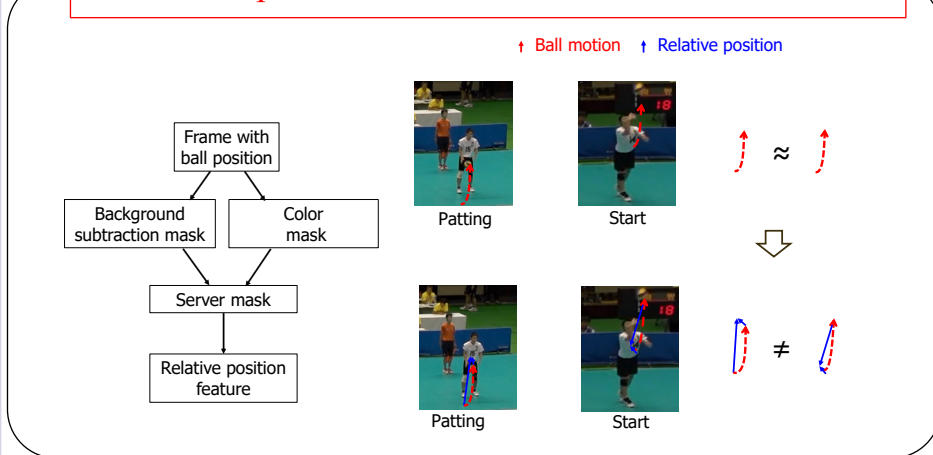
➢ Proposals

Framework

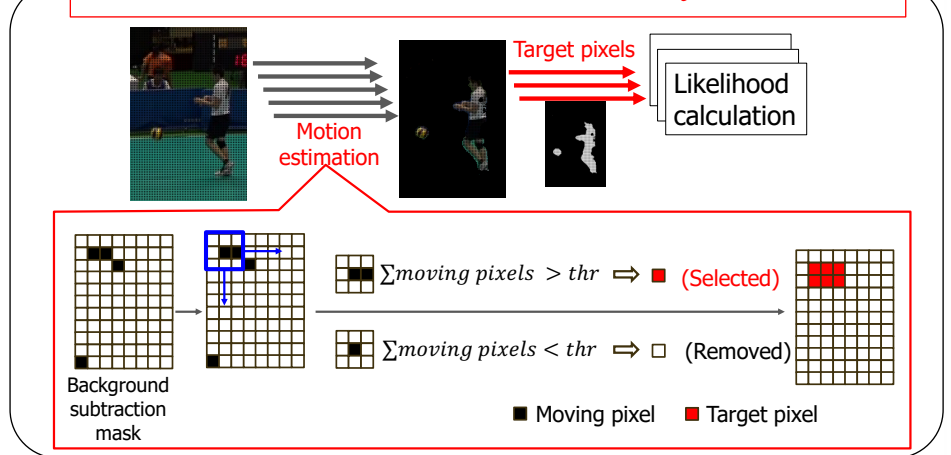P1: Template update method based color likelihood estimation
P2: Relative position between ball and server feature
P3: Motion estimation based redundancy removal

Input sequences → Preprocessing → (GPU) → Template update (P1) → Likelihood calculation → Candidates evaluation → Relative position calculation(P2) → Classification

Template update method based color likelihood estimation

Not updated templates + Updated templates

Likelihood>Threshold

New sample k

K - N　K - 1

Color likelihood estimation

Conventional　　Proposed

High similarity

Frame k

- Ball in frame k (red)
- Fixed template (black)
- Updated template (blue)

Relative position between ball and server feature

↑ Ball motion　↑ Relative position

Frame with ball position → Background subtraction mask / Color mask → Server mask → Relative position feature

Patting　Start　$\approx$

Patting　Start　$\neq$

Motion estimation based redundancy removal

Target pixels

Motion estimation

Likelihood calculation

$\sum moving\ pixels > thr \Rightarrow$ ■ (Selected)

$\sum moving\ pixels < thr \Rightarrow$ □ (Removed)

Background subtraction mask

- ■ Moving pixel
- ■ Target pixel

➢ Experiment results

Table1. success rate

	Criteria	Camera1&Camera2	Camera3&Camera4
Conventional (%)	Recall	70.45	73.81
	Precision	81.58	81.58
Conventional +P1 (%)	Recall	86.36	90.47
	Precision	90.47	92.68
Conventional +P1+P2 (%)	Recall	100	100
	Precision	100	100
Conventional +P1+P2+P3 (%)	Recall	100	100
	Precision	100	100

Table2. time consumption

Tasks	CPU+P1+P2 (ms /frame)	GPU+P1+P2 (ms /frame)	GPU+P1+P2+P3 (ms /frame)
Preprocessing	164	1.15	1.15
Motion estimation	Not included	Not included	4.59
Likelihood calculation	1038	19.56	8.28
Candidate evaluation	63	1.57	1.57
Template updating	31	0.22	0.22
Relative position calculation	96	0.56	0.56
Sum	1392	23.08	16.37

➢ Conclusion

Combining the proposals on GPU, this proposed start scene detection system achieves 100% recall and precision rate with a processing speed of 16.37 ms/frame on the test sequences.