Multi-scale Ball Motion Feature Based Self-correcting Approximation Model for Monocular 3D Volleyball Trajectory Estimation

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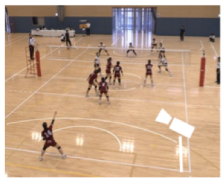
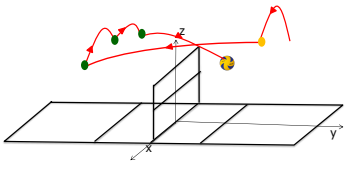
Background

3D volleyball trajectory estimation based on monocular vision



Monocular vision system



3D volleyball trajectory

Problem

① Multi-factors influenced complex trajectory

② Variable trajectory parameters in flight

③ Model drifting problem in monocular vision

Solution

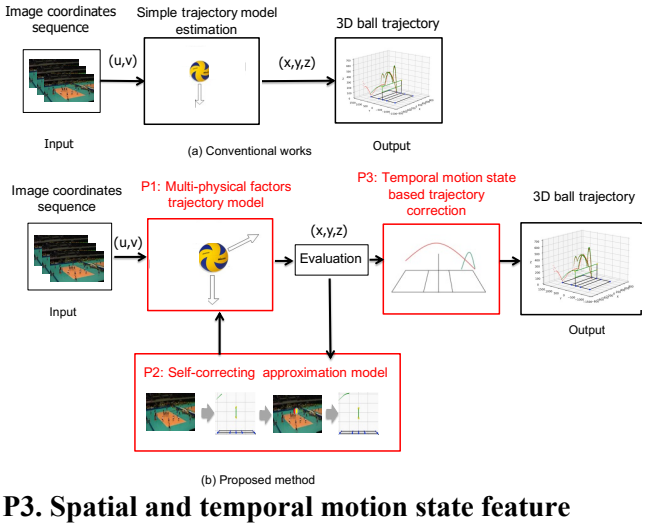
Proposal 1: Multi-physical factors trajectory model

Proposal 2: Self-correcting approximation model

Proposal 3: Spatial and temporal motion state feature based trajectory correction

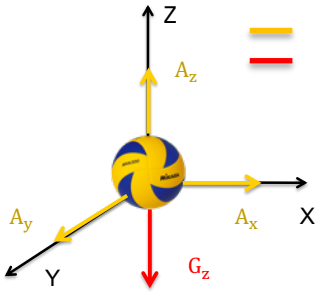
Proposals

Basic framework:



P1. Multi-physical factors trajectory model

➢ Consider gravity and air resistance in trajectory



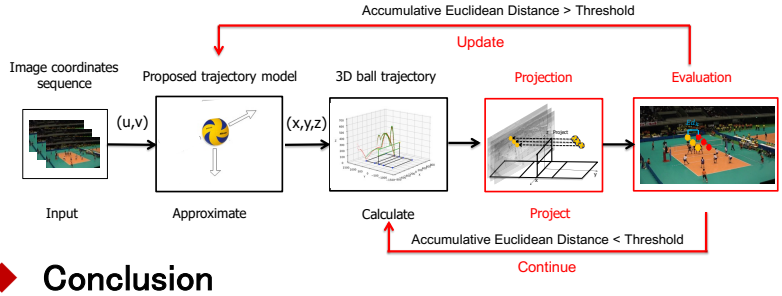
Air resistance

Gravity

$$Px_{k+n} = Px_k + V_x t - a\,V_x\,(nt)^2/2$$
$$Py_{k+n} = Py_k + V_y t - a\,V_y\,(nt)^2/2$$
$$Pz_{k+n} = Pz_k + V_z t + g(nt)^2/2 - a\,V_y\,(nt)^2/2$$

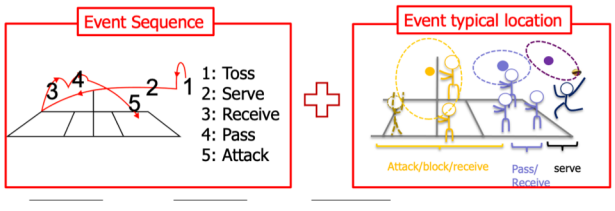
P2. Self-correcting approximation model

➢ Evaluate result and rectify model parameters dynamically



P3. Spatial and temporal motion state feature based trajectory correction

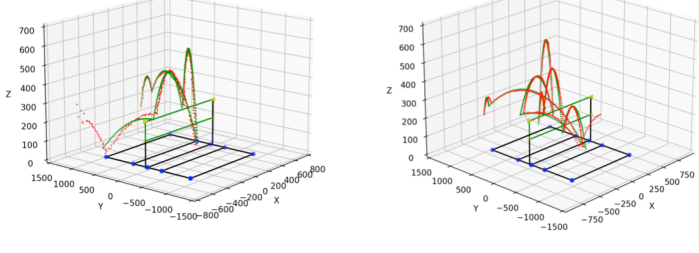
➢ Use events motion feature correct model drifting



Conclusion

The ground truth is Cheng's work result based on multi-view vision system.

Proposed methods achieves 89.4% accurate in error range 150 mm, and 82.7% in error range 200mm



Experiment result

Test Method	Conventional work [1]	Conventional work + P1	Conventional work + P1 +P2	Conventional work + P1 +P2+P3
Error range 150mm [%]	38.3	48.1	74.6	82.7
Error range 200mm [%]	45.5	53.7	79.8	89.4
Average error	50.2cm	45.1cm	25.9cm	20.3cm

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