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Computer simulation-based curling tactical drills research

Peiyu Zhao, Shangbin Li*

Physical Education Department, Harbin Engineering University, Harbin, 150001,
(CHINA)

ABSTRACT

With computer technology rapidly development, computer analog simulation technology has been penetrated into all walks of life. The paper applies computer analog simulation technology into sports event curling, establishes curling tactical simulation system, with an aim to research curling rules and features. The paper firstly renders human body model, gets human body model in computer a, and then establishes curling tactical simulation system, and focuses on researching on model calculation subsystem under tactical simulation system, establishes collision detection model and physical ability attenuation model. Finally it gets physical ability waste estimation method according to athlete works to overcome resistance in competitions, and provides physical ability attenuation formula, and further perfects curling tactical simulation system.

KEYWORDS

Simulation system; Graphics rendering; Collision detection; Physical ability attenuation model; Curling.



INTRODUCTION

Computer analog simulation technology is a kind of comprehensive technology with closely combination between a kind of professional knowledge and computer technology that utilizes computer technology to establish actual system model, and carries on experiments on model under experiment conditions, it has efficient, safety, steady and other advantages that realistic conditions don't have, in recent years, computer analog simulation technology has been rapidly developed, it has already gone into all walks of life, become an important tool in analysis, evaluation, training and other system, sports industry has no exception. The paper combines with computer analog simulation technology and curling movement features, establishes curling tactical simulation system, with an aim to improve Chinese curling sports event sports level.

For computer analog simulation technology and curling sports event, lots of predecessors have made researches, just these predecessors constantly exploration, it let Chinese curling technical level to be steady improved. Among them, Wang Yan (2007) in the article "Short track speeding skating simulation training methods exploring and analysis", provided simulation training general running procedures that were defining simulation objects, defining simulated system boundary, setting homomorphic system and carrying on similarity analysis, subject training system and homomorphic system training together^[1]. Luo Tao (2009) applied computer analog simulation technology into gymnastics teaching training, succeeded in editing and creating new gymnastics motions^[2]. Liu Yang (2011) on the basis of LS→DYNA, made computer analog simulation research on bus head-on collision, utilized HYPERMESH and LS-DYNA software to establish limousine and rigid wall head-on collision finite element simulation model, correctly simplified full vehicle model, which made important contributions to computer analog simulation technology development^[3].

The paper applies computer analog simulation technology into sports event curling, the paper establishes curling tactical simulation system, and focuses on researching on model calculation subsystem under tactical simulation system, establishes collision detection model and physical ability attenuation model. It gets important conclusion, which makes contributions to computer analog simulation promotion and curling development.

HUMAN BODY MODEL RENDERING AND TACTICAL SIMULATION SYSTEM

Establish curling tactical simulation system, firstly is needs to carry on simulation modeling on system's main research objects—athlete, which needs to combine with athletes physiological features, makes simulation, graphics rendering, the paper adopts OGRE graphics engine to make 3D graphics analog simulation. OGRE is a graphic engine with power functions and extremely high efficiency, it can handle with multiple kinds of modeling tools, and generate 3D model and create 3D scenes. Therefore, the paper firstly establishes athlete model as following Figure 1, Figure 2 show.

Except for the human body model, targeted at curling high speed, strong confrontation, fast competition rhythm sports features, it also needs computer intelligent system to make decision in the shortest time, so that ensure simulation system timeliness, so the system makes partial improvement on response equation Agent model, and meanwhile refers to and simplifies Markov decision, and introduces state set, cluster set and motion set functions, reflects model in the form of mathematics, so that it gets the system's improved Agent model.

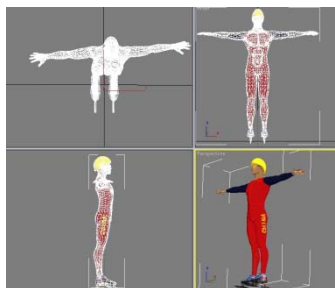


Figure 1 : Athlete model



Figure 2 : Athlete model in moving state

System overall structure

The paper’s curling technical and tactical simulation system contains three layers: visual layer, logic layer and control layer, system overall structure is as Figure 3 shows.

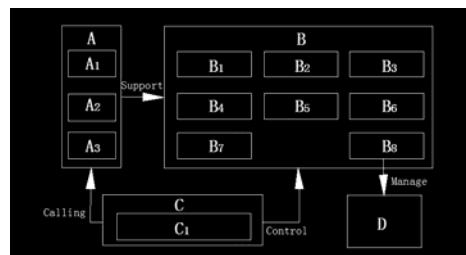


Figure 3 : Curling technical and tactical simulation system structure frame

TABLE 1 : Figure 3 Symbol description

A	View layer	B ₄	Competition environment simulation
A ₁	Graphics engine	B ₅	Auxiliary information indication
A ₂	Physical engine	B ₆	Intelligent agent control
A ₃	Graphical interfaces	B ₇	Competition performance statistics
B	Logic layer	B ₈	Data management
B ₁	Virtual athlete	C	Control layer
B ₂	Athlete management	C ₁	System running frame
B ₃	Peripheral input control	D	System data

In Figure 3, visual layer main function is the indication part of system logic contents; it mainly contains graphics engine, graphical interfaces and physical engine. Graphics engine renders graphics information into screen. Graphical interfaces indication system and users interaction graphical control, and provide programmatic interface. Physical engine is responsible for simulating realistic physical environment, and calculating objects movement trajectory. Logic layer is used to implement system functions, is most important part of system. The system logic layer mainly contains seven parts as Figure 3 shows, each part carries on interaction by system running required data and data management module. Control layer mainly contains system initialization and system frame, system initialization takes charge in creating system required resource manager, rendering window and graphics engine nodes so on.

COLLISION DETECTION MODEL DESIGNING AND IMPLEMENTATION

In curling tactical simulation system implementation process, it mainly includes model calculation subsystem, and model calculation subsystem most important part is collision detection, therefore in the following, it mainly researches on collision detection model designing and implementation.

Collision detection refers to process of judging when two objects occur interaction, in game, collision forms that may exist have following four kinds: The first collision occurs between scene object

and object. The second collision is the collision occurred by particle and object as well as game scene, the third collision is collision of high speed or moving objects, the fourth collision is the collision that after objects occurring collision, no need to get any information about collision while just needs to make detection judgment on whether collision occurs or not, according to curling features, it is clear that it mainly occurs the first kind and the fourth kind collision, the first kind collision is the collision among athlete and external wall, curve attribute block, the fourth kind of collision is used for out-of-bounds detecting when athlete enters into inside track, two kinds of collisions are relative simple collisions, therefore system adopts bounding box collision detection algorithm is most suitable.

Bounding box-based collision detection algorithm

Hierarchical bounding box collision detection is a kind of most widely-used algorithm, its basic thought is utilizing bigger volume geometric shape simple bounding box to make approximately description of complex geometric objects, let athletes shape region to be simple without losing its movement features, so that speed up collision detection speed, and improve collision detection efficiency. Common bounding box divides into AABB axis-aligned bounding box and spherical bounding box two types.

An object axis-aligned bounding box AABB is defined as minimum parallel hexahedron that contains the object and each side is parallel to coordinate axis. As Figure 4 shows, outermost hexahedron is AABB axis-aligned bounding box.

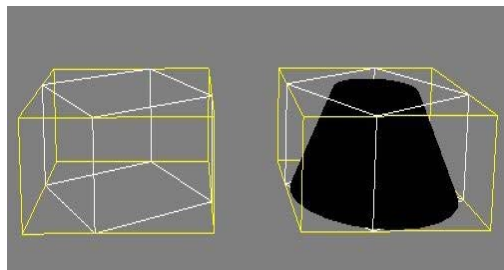


Figure 4 : Curve attribute block AABB

AABB bounding box is not compact enough for athlete, athlete hierarchical bounding body tree will generate more nodes, so that cause lots of bounding boxes carrying on intersection calculation, as Figure 5 shows.

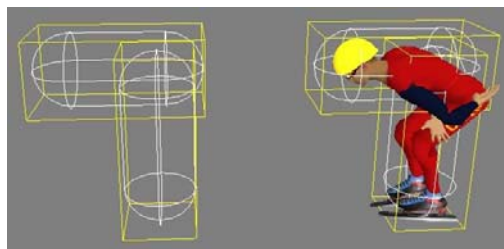


Figure 5: Athlete AABB

Spherical bounding box refers to use a sphere to represent the whole object, when do overlapping test, only need to calculate whether spherical center and another object distance to be larger than radius or not, another object in moving state, spherical bounding body don't needs to reconstruct, only needs to translate in original spherical basis, as Figure 6 shows.

However to general space distribution uneven object (athlete), spherical bounding body compact attribute is poor, as Figure 7 shows, athlete every part is in the shape of capsule, bounding is not so compact, it needs to increase calculation amount and tree establishing depth to improve accuracy.

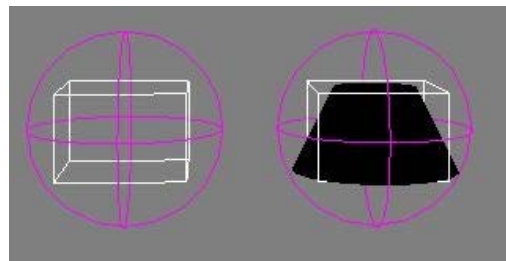


Figure 6 : Curve attribute block spherical bounding box

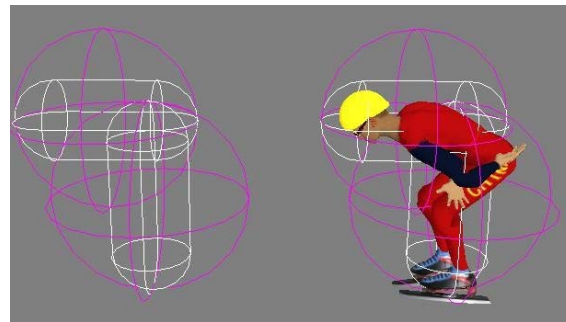


Figure 7 : Athlete spherical bounding box

PHYSICAL ABILITY ATTENUATION MODEL DESIGNING AND IMPLEMENTATION

Short track speeding skating includes starting, straight skating, curve skating, surpassing, dodging, abrupt acceleration, sprint and other technical motions, in different competition motion phases, athlete physical ability consumption is also different, and subsequent competition performing levels are different, informally, it is that if a competition first half physical ability consumption is too big, then it surely will impact on competition second half performing, so only reasonable arrange physical ability consumption then can get better results, so calculate physical ability consumption and apply it into simulation system is particularly important.

Curling athlete during moving process mainly suffers ice surface frictional resistance and air resistance effects, if convert competition process into enough short time phases that is the system's rendering a frame's time, then in the time phase, athlete working ΔW calculation is as following:

$$\Delta W = (f + F_a + F_s) \times \Delta S \tag{1}$$

In formula (1) : f —— ice surface frictional resistance(N);

F_a —— air resistance(N);

F_s —— athlete suffered resultant force(N);

ΔS —— athlete sliding distance during the time phase(m)

Among them, ice surface frictional resistance f computational formula is as following:

$$f = \mu mg \tag{2}$$

In formula (2) : μ —— ice surface friction coefficient

m —— athlete mass(kg)

g —— gravitational acceleration(m/s^2)

Resultant force F_s computational formula is as following:

$$F_s = ma \tag{3}$$

When calculate athlete physical ability consumption, it needs to calculate every frame athlete works, then deducts two frames consumed works, therefore only need to calculate air resistance F_a then can calculate athlete works during the time phase.

In high speed movement process, athlete suffered air resistance cannot be ignored; its computational formula is as following:

$$F_a = \frac{1}{2} AC_w PV^2 \quad (4)$$

In formula (4) A —— athlete windward side area(m^2), athlete windward area A and athlete skating postures have closely relations, to simplify calculation, the system take its average value ;

C_w —— athlete air resistance coefficient;

p —— air density(kg / m^3), the system takes air density in standard conditions $p = 1.293kg / m^3$

V —— air flow speed relative to athlete(m / s)

Combine with formula (1)(2)(4), it can get athlete initial total physical ability W computational formula as following:

$$W = \left(\mu mg + \frac{1}{2} AC_w PV_{\max}^2 \right) S_0 + \left(\mu mg + \frac{1}{2} AC_w PV_a^2 \right) (S - S_0) \quad (5)$$

In formula (5) S_0 —— athlete fast sliding distance(m);

S —— competition total distance(m);

V_{\max} —— athlete maximum sliding speed(m / s);

V_a —— athlete average speed(m / s);

Therefore, final physical ability attenuation formula is:

$$\Delta W = (f + F_a + F_s) \times \Delta S \quad (6)$$

Tactical simulation system detection

The paper calculates athlete physical ability consumption according to 1000m competition instant athlete measurement data and physical attenuation formula (6) as TABLE 2 shows.

TABLE 2 : 1000m competition athlete physical ability attenuation

Performance rank	Performance	Athlete	Attenuation formula result
1	90.11	A5	21870.94
2	90.222	A1	22311.59
3	90.303	A5	21991.94
4	90.306	A4	22528.02
5	90.713	A2	21888.23
6	90.865	A5	21586.64
7	91.179	A5	22094.93
8	91.825	A5	21335.96
9	91.277	A7	21093.28
10	92.134	A6	21131.97
11	92.42	A5	21128.98
12	93.375	A6	20631.01
13	93.536	A3	20739.99
14	97.089	A6	20421.69

According to TABLE 2, it can get Figure 8.

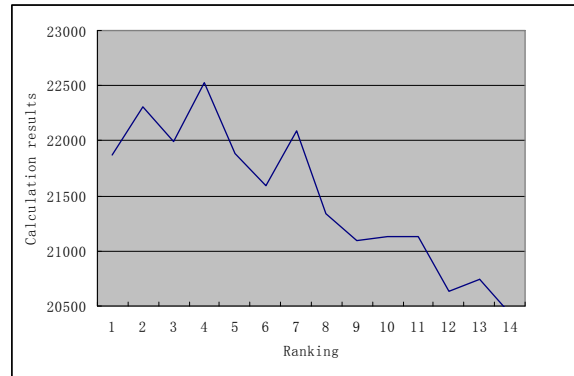


Figure 8 : 1000m athlete rank— physical ability consumption curve graph

According to Figure 8, it obviously can see that overall trend is that athlete with good performance; his physical ability consumption is bigger. It conforms to practice, shows that system setting on physical ability conforms to practical competition status.

CONCLUSION

The paper adopts OGRE graphics engine to carry on 3D graphics analog simulation, gets athlete human body model under analog simulation system; combines computer analog simulation technology with curling sports event, establishes curling tactical simulation system, and researches on tactical simulation system's model calculation such difficult point, establishes collision detection model and physical ability attenuation model, gets physical ability waste estimation method according to athlete works to overcome resistance in competitions, and provides physical ability attenuation formula; combines with relative data to test on analog simulation system, it finds that athlete rank is in direct proportional to physical ability consumption, which proves system's physical ability setting conforms to practical competition status.

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REFERENCES

- [1] Sun Zhong-chun; Analysis of results of Chinese athletes in 20th Winter Olympics[J]. Journal of Wuhan Institute of Physical Education, **40(10)**, 50-53 (2006).
- [2] Ma Yi, Zheng Kai, Chang Bo, Ge Bing-zhu, Yan Hong-guang; Comprehensive Scientific Research Service on Freestyle Skiing Aerial Preparing for 2006 Winter Olympic Games[J]. China Sport Science, **27(2)**, 31-33, 66 (2007).
- [3] Zhao Jing, Yan Yu-dong; Retrospection and Expectation on Development History of Chinese Winter Olympic Games[J]. Journal of Shanghai Physical Education Institute, **36(3)**, 73-75 (2012).
- [4] Liu Jun-jie; Comparison of performances of China and Korea at five Winter Olympic Games and reasons for Koreaps success[J]. Journal of Wuhan Institute of Physical Education, **41(10)**,81-85 (2007).
- [5] Zhu Zhi-qiang; Olympic Winter Games and Their Developmental Trend[J]. Journal of Shanghai Physical Education Institute, **31(4)**, 74-78 (2007).
- [6] Dong Xin, Li Xinghan, Cao Meng; Advantage Sports Events of Sports Powers at Winter Olympic Games[J]. Journal of Shenyang Sport University, **30(4)**, (2011).
- [7] Wang Qing-ming; A Comparative Study on the Attack and Defense Techniques of Women's Handball among China, Denmark and Korea in the 28th Olympic Games[J]. Journal of Capital College of Physical Education, **19(2)**, 85-87 (2007).
- [8] Zhang Xiao-lin; Study on the Competition State of Competitive Sports in China, America and Russia from the Reform and Open Policy[J]. Journal of Xi'an Institute of Physical Education, **27(6)**, (2010).