# **Research on Collision Detection Technology Based on the Extenics**

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Abstract—Research the basic theory of extenics, the extension method, transforming bridge into. The virtual scene roaming algorithm of conventional detection method is complex with huge computation, this article puts forward method of decomposing and decentralizing collision detection of objects by the transforming bridge, and applies this method to the 3D Archive Project, reduce algorithm complexity, improve the efficiency and accuracy.

Keywords-component; extenics; collision detection; 3D; virtual environment; transformingbridge;

## I. INTRODUCTION

## A. Basic extension knowledge.

Extenics is a new subject created by Chinese, it connects mathematics, philosophy and engineering, like cybernetics, information theory, system theory, is a cross subject to a wide range of applications in various disciplines, and engineering applications, it is very fruitful, not only to find new experimental facts, and provides a new idea and approach.

Transforming bridge is one of the methods to solve the contradictory problem. Transforming bridge method is the use of "book, play their proper role" thought, by setting the transforming bridge, connecting or separating opposing sides and the coexistence of transformation method. The transforming bridge method, can make the opposite problem into the coexistence problem. In reference [2], Professor Cai Wen first proposed the transforming bridge ideas and methods, literature [3] and [4] discussed the transforming Bridge Applications in solving non-compatible problems. Literature [5] and [6] put forward the concept of transforming bridge and turning matter element, structure and the transforming bridge system and method of construction are discussed. The literature [10] introduces a complete concept and process of transforming bridge to solve the opposite problem.

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Collision detection is very important in the 3D game, good collision detection require that characters can move smoothly in the scene, when encountering the steps, it can go up automatically, if the steps is high enough, characters must be blocked. To meet these requirements, there must be enough Accuracy and stability, prevent figure wall under special circumstances and fall out of the scene.

A collision detection system should be able to deal with hundreds of thousands of moving objects in the scene, if there is N objects in the scene, you need to test O(N2).

# II. THEORETICAL ANALYSIS

In [10] complete flow is proposed to solve the opposite problem of the process, including the following steps:

(1) Establish extension model of antithetical problem

(2) Construct separative part Z of object O in condition basic-element, to let  $O = S_1 | Z | S_2$ 

(3) Conduct decomposition transformation of condition basic-element

(4) Conduct corresponding transformation of goal basic-element

(5) Judge whether  $(G'_1 \wedge G'_2) \downarrow L'$ , if yes turn (6), if not, turn (2)

(6) Z is separative transforming part

The antithetical problem is transformed to coexistent problem.

# III. SYSTEMS ANALYSIS

## A. Scene analysis.

There are N static objects in the scene, M dynamic objects, a total of N+M objects, if we use technology of bounding box collision detection each frame, to detect whether a collision happens, we need to test for the number

of 1+2+3... ... + N+M-1= (N+M-1) (N+M) /2 times, the algorithm complexity is O ((N+M) 2). The number of entities is so large, the complexity of the algorithm is high and effect sefficiency, refresh frequency automatically reduces in the scene, scene counterchange is not continuous. The algorithm complexity and efficiency form the antithetical problem.

# B. Structure of transforming bridge

All entities are in the same scene, put all the entities in the same vector, and when doing collision detection, turn out each entity, test whether or not a collision happened with any other entites.

$$G_{1} = \begin{bmatrix} \text{static entity setO}_{1} & \text{position} & \text{vectorS}_{1} \\ \text{amount} & \text{N} \end{bmatrix} = \begin{bmatrix} O_{1} & c_{1} & v_{11} \\ c_{2} & v_{12} \end{bmatrix} (1)$$
$$G_{2} = \begin{bmatrix} \text{Dynamic entity setO}_{2} & \text{position} & \text{vectorS}_{2} \\ \text{amount} & \text{M} \end{bmatrix} = \begin{bmatrix} O_{2} & c_{1} & v_{21} \\ c_{2} & v_{22} \end{bmatrix} (2)$$

L = [scene O frame repetition frequency M] = [O, c, v](3)

Then

$$(G_1 \wedge G_2) \uparrow L \circ \tag{4}$$

We make separative part Z of condition object O, to let

$$O = S_1 \mid Z \mid S_2 \tag{5}$$

and then we have decomposition transformation of condition basic-element.

$$TL = L' = \{L_1, L_2\}$$
(6)

$$L_1 = \begin{pmatrix} S_1 Z, & c, & v_1 \end{pmatrix}, \tag{7}$$

$$L_2 = \begin{pmatrix} ZS_2, & c, & v_2 \end{pmatrix}, \tag{8}$$

$$v_1 \oplus v_2 = v \tag{9}$$

We make the corresponding transformation of goal basic-element

$$T_{i}G_{1} = G_{1}' = \begin{bmatrix} \text{static entity set}O_{1} & \text{position } \text{vector}S_{1}Z \\ \text{amount} & N \end{bmatrix} = \begin{bmatrix} O_{1} & c_{1} & v_{11} \\ c_{2} & v_{12} \end{bmatrix}, (10)$$
  
and

$$G_1' \Rightarrow G_1$$
 (11)

$$T_{2}G_{2} = G'_{2} = \begin{bmatrix} Dynamic entity setO_{2} & position & ZvectorS_{2} \\ amount & M \end{bmatrix} = \begin{bmatrix} O_{2} & c_{1} & v_{21} \\ c_{2} & v_{22} \end{bmatrix}, (12)$$
and

$$G_2' \Rightarrow G_2$$
 (13)

then

$$(G_1' \wedge G_2') \downarrow L', \qquad (14)$$

where

$$O = S_1 \mid Z \mid S_2 \tag{15}$$

is separative transforming matter.

After conversion, the algorithm complexity is

$$O(N2) + O(M2),$$
 (16)

compared with unused conversion bridge of the complexity of the algorithm is O((N+M) 2), it has been basically meet the goals and conditions, but we continue to use the transforming bridge to isolated objects.

On the dynamic entity set

$$B = \begin{bmatrix} Dynamic entity setO_2 & position & vectorS_2 \\ amount & M \end{bmatrix} = \begin{bmatrix} O_2 & c_1 & v_{21} \\ c_2 & v_{22} \end{bmatrix} (17)$$

Using decomposition analysis in extension analysis to decompose the basic-element.

$$B // \{B_1, B_2, \dots, B_m\} \circ$$

$$\ell = \begin{bmatrix} \text{static entity set} O_1 & \text{position scene } 0 \\ \text{Relationship disjoint} \end{bmatrix} (18)$$

$$(O, c, c (O)) // (\ell) \{ (O_1, c, c (O_1)), \\ (O_2, c, c (O_2)), \dots, (O_m, c, c (O_m)) \}$$

$$B = \begin{bmatrix} Dynamic entity setO_2 & position & vectorS_2 \\ & amount & M \end{bmatrix} // (\ell)$$

$$\{\begin{bmatrix} Dynamic entity setO_2' & position & vectorS_2 \\ & amount & M_1 \end{bmatrix},$$

Dynamic entity set 
$$O_2'$$
 position vector  $S_2$   
amount  $M_2$ , ...

$$\begin{bmatrix} Dynamic entity setO_2' & position & vectorS_2 \\ & amount & M_n \end{bmatrix} \} (19)$$

And

$$M_1 + M_2 \dots + M_n = M$$
; (20)

Similarly to the M conversion, converted results as follows:

$$T_{1}G_{3} = G'_{3} = \begin{bmatrix} Dynamic entity setO_{1}' position vectorS_{3}Z \\ amount M_{1} \end{bmatrix} (21)$$

$$T_{1}G_{3} = G'_{4} = \begin{bmatrix} Dynamic entity setO_{2}' & position & vectorS_{3}Z \\ & amount & M_{4} \end{bmatrix} (23)$$

$$T_{1}G_{n+2} = G'_{n+2} = \begin{bmatrix} Dynamic entity setO_{n}' position vectorS_{3}Z \\ amount M_{n} \end{bmatrix} (24)$$

Then

$$(G'_1 \wedge G'_3 \wedge G'_4 \wedge \dots \wedge G'_{n+2}) \downarrow L' \circ \qquad (25)$$

And

$$O = S_1 | Z | S_2 | Z | S_3 | \dots | S_{n+1}$$
 (26)

is the separative transforming matter.

Do the same conversion on the static entity, directly to label the static object, says this is not going to.

# IV. APPLICATION CASE

## A. The project background

In the 3D file in the project, established the 3D roaming scene, the camera cannot pass through walls, cannot pass through other static entity either, shelves in the archives is mobile, the camera is not through the shelves, shelves are not mutually through.

#### *B.* core algorithm



Figure 1. result of execution algorithm

# V. EXPERIMENT RESULTS AND ANALYSIS

We selected five scenarios to be tested, the test results are as fellows:

TABLE1

The name of the scene-	Total num- ber of enti- ties-	The static number of enti- ties-	The static number of enti- ties-	average finme rate without celli- tion detection-	average frame rate using tradi- tional methods of collision de- tection of	average frame rate using trans- forming bridges methods of colli- sion detection-
scenel-	324	16-	B-1	18,84	16.40	17.34
rome 24	56-	6/	40+	14.5	12.70	13.9/
scene 34	1798	105-	24+	12, 5-1	8.6-	9.54
scene 44	240-2	2004	20+	8.94	5.52	7.64
rosne 52	334-	264-	234	7.9.	5.1-	1.2/

As you can see, using a separate base method is better than the method without the use of the frame and rate is faster, especially in static entities accounted for a large number of entities, and the maximum dynamic entity for the smaller cases, improvement of the efficiency is more obvious.

## VI. THE END

Through the design of transforming bridge, introducing the map separation dynamic entity set, method of directly labeling static objects on the map, reduce the complexity of the system, improve the efficiency, translate the antithetical problem into the coexistence problem, which is important to the realization of virtual scene roaming.

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