Collision Detection: Hierarchical Algorithms

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Outline

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Pre-computation Phase

- There is a geometric primitive, e.g. a sphere.
- Let O be a 3D object with surface S composed of triangles.
- There is a pre-computation phase, in which each triangle in S is enclosed in the smallest geometric primitive.
- A tree data structure is built, the tree has as leaf nodes the triangles enclosed in the geometric primitive.
- The tree can be built using a top-down approach. Recursively a volume is split into two sets E_1 and E_2 having the same cardinality of leaves.
- The partition is finished when the nodes in the tree have each one a single geometric primitive containing a single triangle.
- It is suitable to have a balanced tree.

Hierarchical Algorithm

- Let O_1 and O_2 be two objects and T_1 and T_2 their respective trees.
- The collision test is done traveling the trees, using a deep-first search method. Pairs of nodes in the trees are examined.
- If the volumes associated with the vertices do not intersect then they are pruned of the trees.
- If the volumes associated with the nodes intersect then the child nodes are examined.
- Eventually if the terminal nodes intersect then the triangles themselve are checked for collision.

Recursive Algorithm

- Let r_1 and r_2 be the root vertices of the trees T_1 and T_2.
- $vol(v)$ denotes the volume associated with the vertex v, left-child(v) and right-child(v) design the two children of v if v is not a terminal (leaf) node.
- Recursive algorithm COLLIDE(r_1,r_2)
    1. If $vol(r_1) \cap vol(r_1) = \emptyset$ then return 0.
    2. If r_1 and r_2 are leaf nodes then test the triangle for collision.
       If there is collision return 1, otherwise return 0.
    3. If $vol(r_2) < vol(r_1)$ then switch r_1 and r_2.
    4. If COLLIDE(r_1, left-child(r_2)) = 1 then return 1.
    5. Else if COLLIDE(r_1, right-child(r_2)) = 1 then return 1.
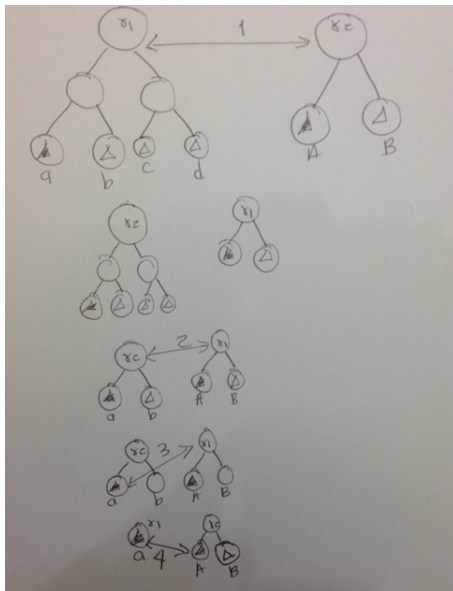   6. Else return 0.

Recursive Algorithm

Figure: Graphical description

Thanks... Questions?

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