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Spherical data and ray tracing of surfaces in n -dimensional space.

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Summary: In this paper, we propose a new method for ray tracing which visualizes parametric surfaces in higher-dimensional spaces by using spheres. Though our method looks like the method of bounding volume in the point to use spheres, it is different in the point to approximate the intersection itself with the intersection of the sphere and the ray. We introduce tree structure into this set of spheres to reduce the number of ray-surface intersection calculations. This tree structure is induced by inclusion relations between spheres. If a sphere S contains a sphere S' , we call S a super-sphere and S' a sub-sphere in S . When a given ray hits a super-sphere S , we must check if this ray hits sub-spheres in S . On the other hand, if the ray does not hit the super-sphere S , we can omit to check sub-spheres. We call this set of spheres with tree structure spherical data. Ray tracing of surfaces in higher dimensional spaces (also in three-dimensional space) is carried out easily by using spherical data. Furthermore, we can give some effects to surfaces by using spherical data. For example, we can give thickness to the given surface. We can also add an unevenness like ripples to the given surface. As for ray tracing of surfaces, the method which patches are used for is well known. But, in n -dimensional space ($n \geq 4$), the sum of the dimension of a patch and the dimension of a ray is less than 3. So, It is difficult to search the intersection. On the other hand, in the case of spherical data, the sum of the dimension of the sphere and the dimension of a ray is always equal to the dimension of the space. So, the point of intersection can be found easily. This is a big advantage of spherical data.