Research for Skin Radiation Damage Extent Assessment Methods

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1. Introduction

ICRP [1] defines the dose limit of skin exposure as the following. 'The recommended annual limit is 500mSv averaged over any 1cm^2, regardless of the area exposed'. This perspective serves to manage the dose on the average of the 1cm^2 area of the highest dose: thereby prevent deterministic effects, and conservatively prevent stochastic effects. There is also another additional recommendation: 'In practice, monitoring is carried out at representative locations for external exposure and over averaging areas for contamination. The guidance given in Publication 35(1982) on averaging areas is still valid'.

However, such recommendations are hard to follow in real situations. For external exposure, the posture of the subject must be appropriately described. It is especially hard to define the distance between the radiation source and the subject for complex structures like fingers. This study suggests that this problem can be solved by a method that scans the subject body and posture in 3D and runs a simulation of the subject. The base technologies necessary for that method are to be discussed.

There are many commercial systems that reads subject posture and external appearance. Therefore, this study focuses on the works that need to be done in order to run a simulation from the acquired data. That is, the development of algorithms that voxelize polygon models.

2. Methods and Results

2.1 Scanning of different bodies and different postures

Skin external exposures make a retrograde dose evaluation a necessity. Therefore, the situation at the time of exposure must be represented . In order to accurately describe the characteristics of the subject's posture at the time of exposure, the exposed subject must personally give the commom postures at work. If the exposed subject is unable to do this, another person with a similar physique as the subject may do the postures instead of the subject. However, such substitution causes errors because the posture must rely on verbal interviews, etc. The subject's external appearance and posture can be made into a polygon model using a commercial 3D shape reconstruction system, such as the optical system and the laser system. This study reconstructed the hand using Flexscan 3D, then voxelized it

Figure 1 is a polygon model using Flexscan 3D, of a hand that is about to pick up a certain object. One of the major causes of radiation exposure in nondestructive inspection companies is when a person picks up the radiation source by mistake. It can be seen that the shape and location of the exposed area is accurately described.

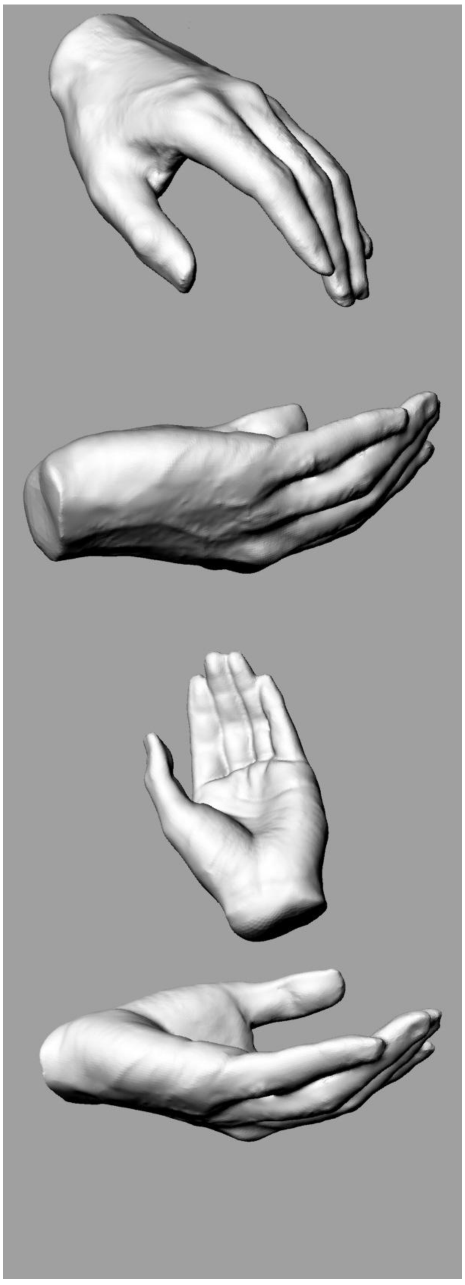

Fig. 1. Polygon model of a hand about to pick something up (using Flexscan 3D system)

2.2 Voxelization

The voxelization algorithm is as the following. Fist, the maximum and minimum value on the Z axis are found. An equation of the tangent line between the Z-axis surface that increses of decreases by the wanted voxel size and the triangle that passes the surface. To find the two extreme points of thet tangent line, the contact points with the three sides of the triangle are found out and the point that does not exist within the triangle is discarded. At this step, a total angle sum of 360 degrees were verified to make sure that the point is located in the triangle. The two extreme points of the tangent line are listed, lines are drawn between the points, then polygons are created. When the inside of the polygon is painted with a color, voxel data corresponding to a page is created.

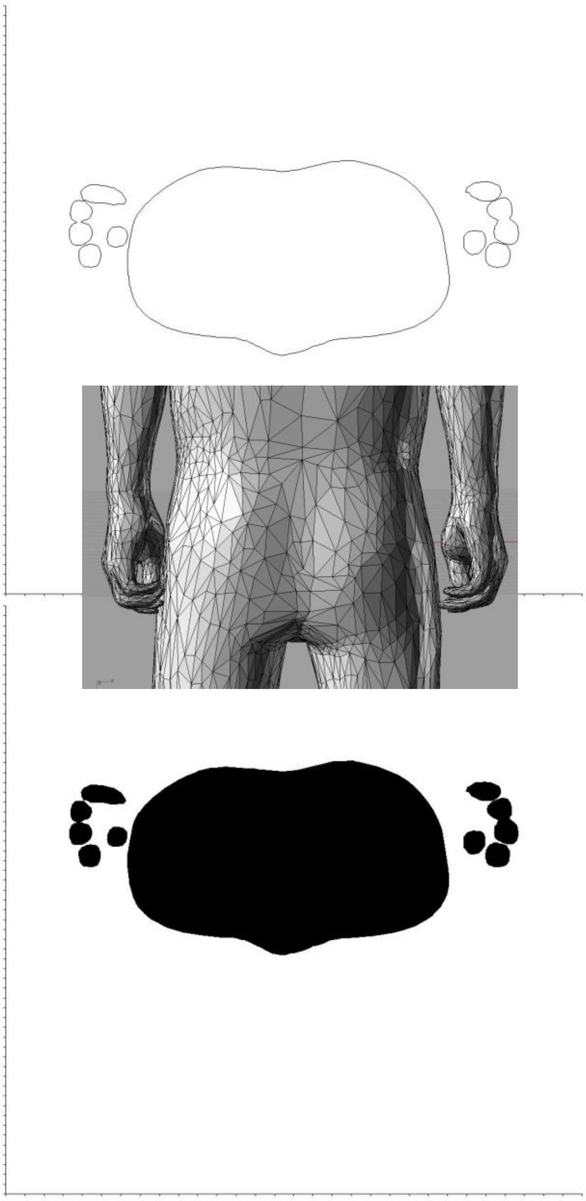

Fig. 2. Transformation from a polygon model to a voxel model of a randem section Top: Sum of tangent lines between the polygon model and the random Z-axis surface, Middle: Circular polygon model, Bottom: Data input inside Top (Voxel model)

Figure 2 is a captured image of the process of transformation from a polygon model to a voxel model, by steps above and below. The section is a Z-axis section of the polygon model, at about the finger level. A polygon model is a multi-surface figure made of triangles. Therefore the cut surface becomes a polyhedron, like the top part of Figure 2. When the inside of such a polyhedron is uniformly filled, it becomes a voxel mode.

3. Conclusions

Transformation from a polygon model to a voxel model was successful. A program for the transformation was produced. Before distribution, it is neccessaty to check whether the program performs well with more various polygon models.

REFERENCES

[1] International Commission on Radiological Protection, 1990 Recommendations of the International Commission on Radiological Protection, ICRP publication 60, Annals of the ICRP, Pergamon(1991).