DIGITAL HUMAN BODY MODELS FOR ACCIDENT RECONSTRUCTION

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INTRODUCTION

Using digital human body models, two cases of fatal accidents, a high fall and a rifle gunshot on the head occurred under circumstance that cast doubt on the official verdict. Both of these accidents were reconstructed to clarify and visualize the accident processes in detail.

METHODS

The HARB (Human Articulated Rigid Body) model consisting of 22 kinematic joint elements, and 23 rigid segments was used to reproduce the kinematics and kinetics of the victim's body during those high fall and gunshot accidents. This information was applied to various biomechanical injury criteria to assess the risks of injuries. The computed injury risk and patterns were then compared with the reported victim's state of injuries. Based the victim's limited anthropometric information such as just height and weight available to us, we estimated remaining body dimensions using correlation and linear regression analyses. Our domestic national size survey database, SizeKorea was utilized for those analyses. The dynamic properties such as segmental mass, mass moment of inertia, and COG were then calculated by GEBOD.

Considering findings (physical evidence) and testimonies (verbal evidence) at the scenes, various input parameters in the sensitivity analysis were carefully selected. The range of those parameters was then determined from the experimental measurements employing either human volunteers or animals.

RESULTS AND DISCUSSION

The main issue for the first case, a high fall in an elevator tunnel of a high rise apartment building under construction were the suspicious multiple hits on intermediate working floors. It was apparent that the victim had started the fall from the 15th floor because of the foot print found at the elevator door sill. The body of the victim was found at the basement floor of the tunnel but there were two working floors at the 5th and 3rd levels with narrow gaps on the side. So, the victim seemed to continue falling toward the 3rd floor and the basement following the first hit on the 5th floor. Since there was only a narrow gap between each floor and the side wall of the tunnel, the feasibility of these serial falls seemed unlikely. So, we tried to reconstruct the overall falling route and calculated the injury risks from each successive fall. From the simulation, we found that the first hit was not so fatal to the victim due to the considerable amount of structural deformation of the 5th floor which mitigated the impact of the fall. So the victim was still capable of creeping toward the wall and sinking into the gap to continue on with the next fall to the downstairs.

The main debate for the second case, the rifle gunshot on the head, was an apparent dissonance between the final position of the body (lying on the right side) and the direction of apparent bullet path into the head(to the left). In the simulation, the bullet penetration was modeled with equivalent nodal forces on the human body model. The sensitivity study revealed that the final position of the body depends on the initial gunshot posture of the victim and the final position was found to be quite feasible given certain realistic initial conditions.

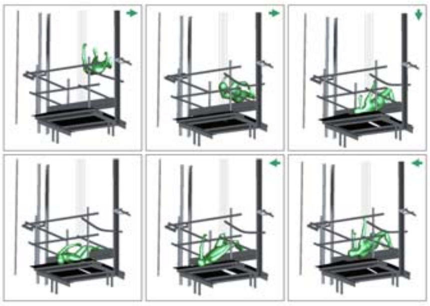

Figure 1 High fall case

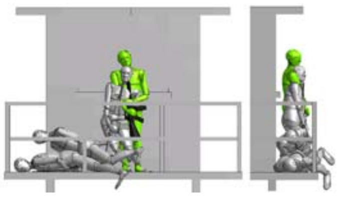

Figure 2 Gunshot case

CONCLUSIONS

The applicability of digital human body models in the fatal accident reconstruction was successfully demonstrated in this study. Starting from the initial postures taking ergonomic factors into consideration, final positions and the associated injury risks of the victims were all effectively simulated and predicted. These outcomes with visual effect were able to help us to elucidate the accident process more accurately.

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