Perception of Size Variations in 3D Virtual Garment Simulation

Dong-Eun Kim, California State University, Long Beach

Keywords: 3D garment simulation, size, fit

Introduction: Three-Dimensional garment simulation is an innovative technology enabling apparel product developers to view a realistic 3D image of a garment before physical sample making steps. The benefit is reduced time and money spent on sample making for fit evaluation. However, in order for apparel industry to widely accept this technology, it needs to be proved that the technology is capable of showing different garment size variations accurately. Psychophysics is a part of experimental psychology studying the relation between stimulus and perceiver's sensation. When people visualize an image, people's perception of image cannot be directly measured. Psychophysics develops experimental methods to objectively measure our subjective perceptual experiences (Gescheider, 1997; Ferwerda, 2008). This study aimed to investigate the level of size variation that viewers can perceive with 3D garment simulation technology and to examine how accurately the technology allows viewers to perceive garment size variations through psychophysical experiments. Three research questions were: (Q1) What is the relation between virtual pants size variation and viewers' perception of pants size? (Q2) Can viewers differentiate virtual pants size variations and rank pants size from the smallest size to the largest size? (Q3) What are viewers' opinions of using the garment simulation technology?

Methods: Thirty-seven Apparel Design students were recruited from an U.S. university. The stimulus was a PowerPoint file containing 3D pants in 11 different sizes simulated on a same size 3D virtual model. The 3D images were created using a 2D/3D patternmaking software system. Size 8 pants patterns were graded so that the pants sizes were larger or smaller by half inch total in circumferences between the sizes. Each pair of pants was labeled with a size number: 00, 0, 2, 4, 6, 8, 10, 12, 14, 16, and 18. The size numbers did not necessarily correspond to a commercial pants size number. Two types of psychophysical experiments were developed: a rating experiment and a ranking experiment. Participants completed a questionnaire based on viewing the PowerPoint file. Section 1 of the questionnaire had 11 slides and each slide showed a pair of size 8 control pants and a pair of test pants side-by-side without a size label. Participants evaluated the size differences of the test pants compared to the control pants on a 7-point rating scale (Ex: 1=*Extremely Looser*, 7=*Extremely Tighter*) at six locations: overall size, waist, abdomen, hip, crotch, and hem length. Section 2 had six slides. Each slide contained 6 pairs of pants in a random order without a size label. With each slide, participants ranked the six pants from the smallest to the largest size. Slide 1 and slide 2 contained sizes 00, 2, 6, 10, 14, and 18 in front views and in side views, respectively. Slide 3 and slide 4 contained sizes 00, 0, 2, 4, 6, and 8 in front views and in side views, respectively. Slide 5 and slide 6 contained sizes 8, 10, 12, 14,

16, and 18 in front views and in side views, respectively. With section 3, participants answered questions regarding their opinions of using 3D garment simulation in evaluating garment size.

Results and Discussion: (Q1) Pearson Coefficient Correlation analysis was conducted to investigate the relationships between test pants size variations and participants' size comparison ratings. Participants' ratings of each six pants location were significantly correlated with test pants size variations ($p<0.01$) with strong negative correlations: pants size vs. overall size rating (r=-.813**); pants size vs. waist size rating (r=-.723**); pants size vs. abdomen size rating (r=-.777**) ; pants size vs. hip size rating (r=-.819**); pants size vs. crotch size rating (r=-.813**); pants size vs. hem length rating (r=-.825**). The results indicated that as the test pants sizes were bigger, participants' perception of the size differences between the test pants size and control pants size were greater at all six pants locations. Although all pants had the same length, participants perceived the hem length variations. This is because as the pants circumferences became larger, the pants sat lower at the waist, which made the hem length seeming longer. **(Q2)** The descriptive statistics results from ranking experiments from slides 1 and 2 showed that participants could to rank the pants size in correct orders 70% - 90% of the time. The results from slides 3 and 4 showed that participants could rank the pants in correct orders 47% - 70% of the time and from slides 5 and 6 participants could rank the pants in correct orders 21% - 65% of the time. The results indicated that participants' ranking performance was better with slides 1 and 2, which had 1″ circumference differences between the sizes than with slides 3, 4, 5, and 6, which had 1/2″ circumference differences. Participants' ranking performance did not show any clear differences between viewing front-view images and side-view images. **(Q3)** When asked how easy or difficult the size variation tests were using the virtual simulation on a 7-point scale, participants showed a neutral opinion (M=4.0; SD=1.32). Additionally, participants were somewhat satisfied with using the technology (M=5.04; SD=1.15), and they were slight likely to use the technology for evaluating apparel fit in apparel industry (M=4.74; SD=1.48).

Conclusion: This study suggests that 3D garment simulation is capable of showing garment size variations somewhat clear enough for viewers to perceive size differences. Although participants made mistakes on ranking the virtual pants sizes, the size variations in 3D simulations were visible to the participants to some degree. As suggested from the rating experiment results, participants had abilities to perceive the size variations of 3D pants simulation as small as ± 0.5″ and had abilities to differentiate larger sizes as larger and smaller sizes smaller. This study shows positive indications that 3D garment simulation can be reliably used for garment size evaluations in apparel industry.

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