

# Exploration of Core Material Appearance Features

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Digital representations of materials are widely used in various applications. However, understanding their visual properties from human vision perspective and automatically interpreting the visual properties of captured materials remains an ongoing research challenge [1].

To identify the most crucial appearance attributes of real materials, we conducted a user study involving 210 materials, including fabric, leather, wood, plastic, metal, and paper (see Figure 1, left panel). For each material, we recorded a video showcasing both its specular and non-specular appearances. The materials were grouped into three separate movies each showing 70 randomly selected materials. Participants were then asked to identify and rank at least five most visually distinguishing features, in the order of importance, that set apart the materials within each video – essentially, the features that make materials different. We collected a total of 451 valid text responses from 32 participants. Subsequently, a manual semantic clustering based on keywords occurrence revealed the 15 most frequently mentioned attributes (as illustrated in Figure 1, right panel).

In the second validation study, we tasked six participants with clustering all 451 responses according to 15 predefined attributes. The interrater agreement was notably high, as evidenced by Fleiss' Kappa score of 0.786. Among the 451 responses evaluated, we identified 198 instances in which all six raters reached a unanimous consensus (43.9%). If we lowered the threshold to require agreement from at least three raters, we found 254 cases with such consensus (56.3%). Additionally, for a two-rater agreement criterion, we observed agreement in 396 cases (87.8%). This system yielded a situation where 16 out of 32 participants had their responses completely integrated within the rating system, while the remaining 16 participants exhibited a range of 5.6% - 26.7% divergence.

Our findings reveal that the most prominent attributes include common visual features as color variability, saturation, roughness, brightness, shininess, texture, and pattern. Interestingly, participants frequently mentioned tactile and subjective attributes like warmth, hardness, naturalness, and attractiveness.



Figure 1. A collection of materials used in our study (left) and identified 15 material attributes ordered based on their importance specified by occurrence and order in participants list (right).

## References

1. Deschaintre, V., Guerrero-Viu, J., Gutierrez, D., Boubekeur, T., & Masia, B. (2023). The Visual Language of Fabrics. *ACM Transactions on Graphics (TOG)*, 42(4), 1-15.