

Estimating material properties of cloth from dynamic silhouettes

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Deformable materials such as cloth exhibit most of their mechanical properties (e.g., stiffness) from motions caused by external forces. Previous research shows that humans can estimate mechanical properties of cloth such as bending stiffness by observing its motions. However, it is unclear how dynamic behavior alone can convey mechanical properties without the appearance of surface textures and surface reflectance. Here, we extracted silhouettes of moving cloth under wind forces from videos. We hypothesize that the motion of silhouettes alone can be a sufficient cue to allow estimation of cloth mechanical properties.

The experimental stimuli are videos of hanging cloth subject to wind forces. We conducted two experiments via Amazon Mechanical Turk. At each trial, a user is presented a pair of videos (which contains two different cloth samples) and is asked to predict which cloth has a higher bending stiffness. 85 users finished 1800 paired-comparisons (300 trials • 3 repetitions • 2 Experiments). The first experiment used the original videos of the hanging cloth. The second experiment used videos with the same subjects, but only presenting the silhouette of the cloth. Silhouettes are constructed by extracting the outline of the cloth at each frame. By presenting only the silhouette, we remove other visual cues (such as textures and reflectance) and isolate the dynamic motion. Overall, the cloths were perceived with similar accuracy (60% across all trials) for the original videos and the silhouette videos. Also, both experiments had better accuracy when the difference between cloth samples was larger (the difference being measured by bending stiffness).

The results show that dynamic silhouettes can be sufficient to perceive mechanical properties of cloth without surface information such as textures for most cloth samples. This indicates that it is possible to only simulate the dynamics (without photorealistic rendering of detailed textures) to maintain perception of mechanical properties of cloth.