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Modeling yarn-level geometry from a single micro-image

Key words: Single micro-images; Yarn geometry; Cloth appearance

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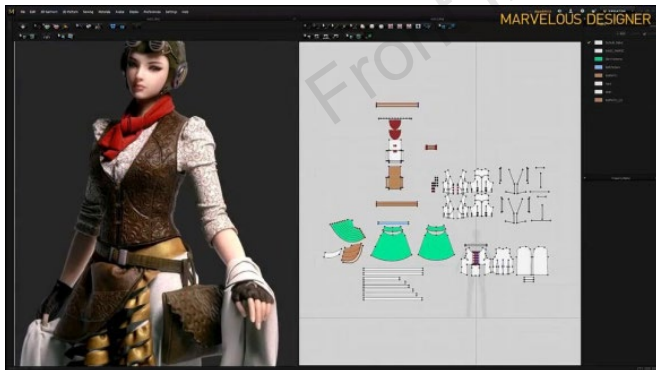
Cloth rendering is important for many applications



Virtual fitting



Film production



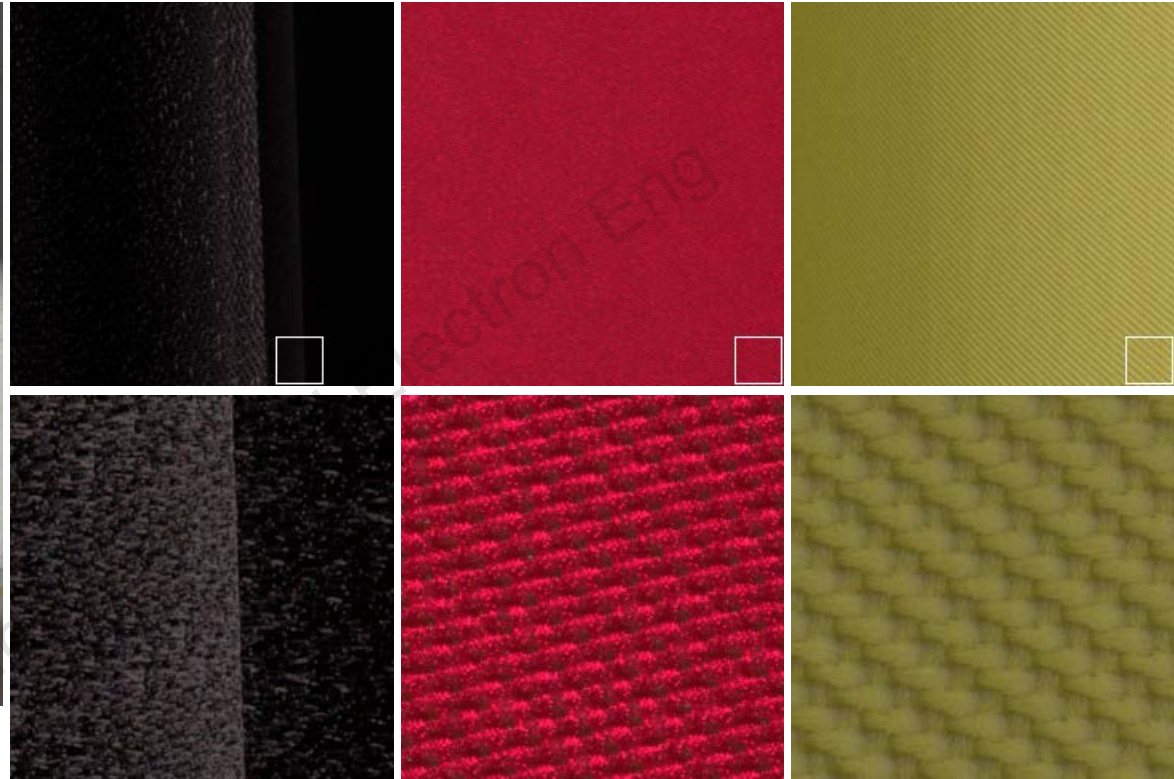
Garment design



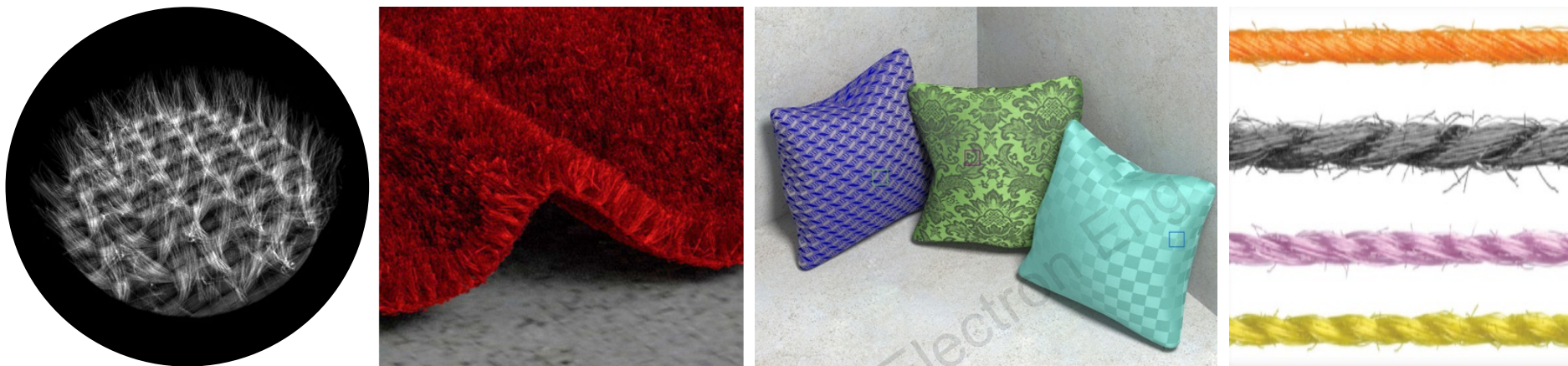
Computer games



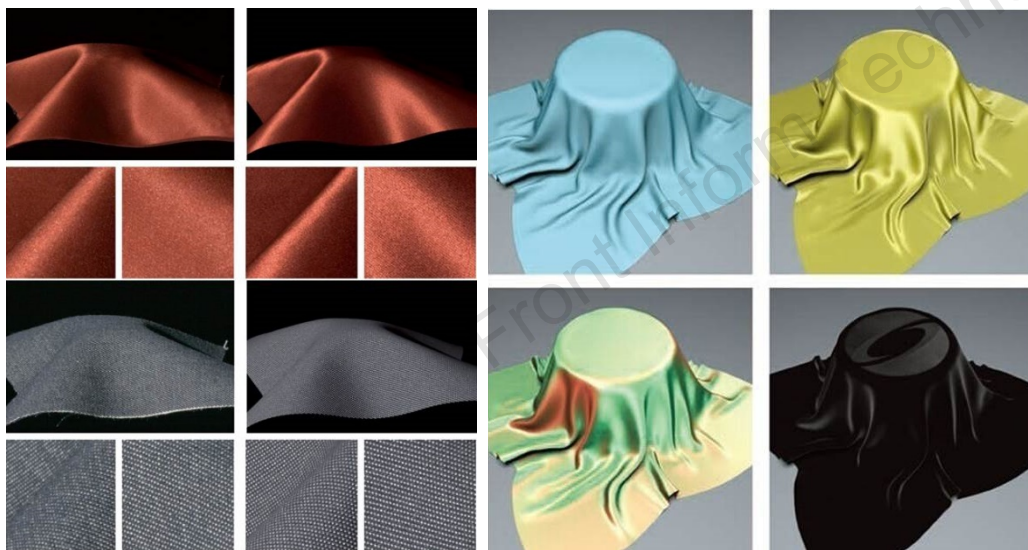
[Khungurn *et al.*, 2015]



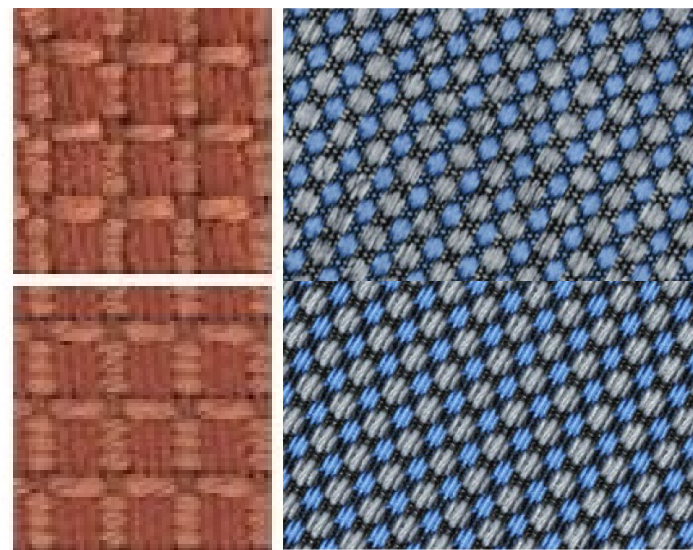
Yarn struct is crucial to photo realistic rendering of cloth!



Volumetric appearance from micro CT [Zhao *et al.*, 2012, 2014, 2016]



Micro cylinder based cloth appearance model
[Irawan and Marschner, 2012; Sadeghi *et al.*, 2013]



Cloth structure modeling from a single image
[Schröder *et al.*, 2015]



Volume-based:

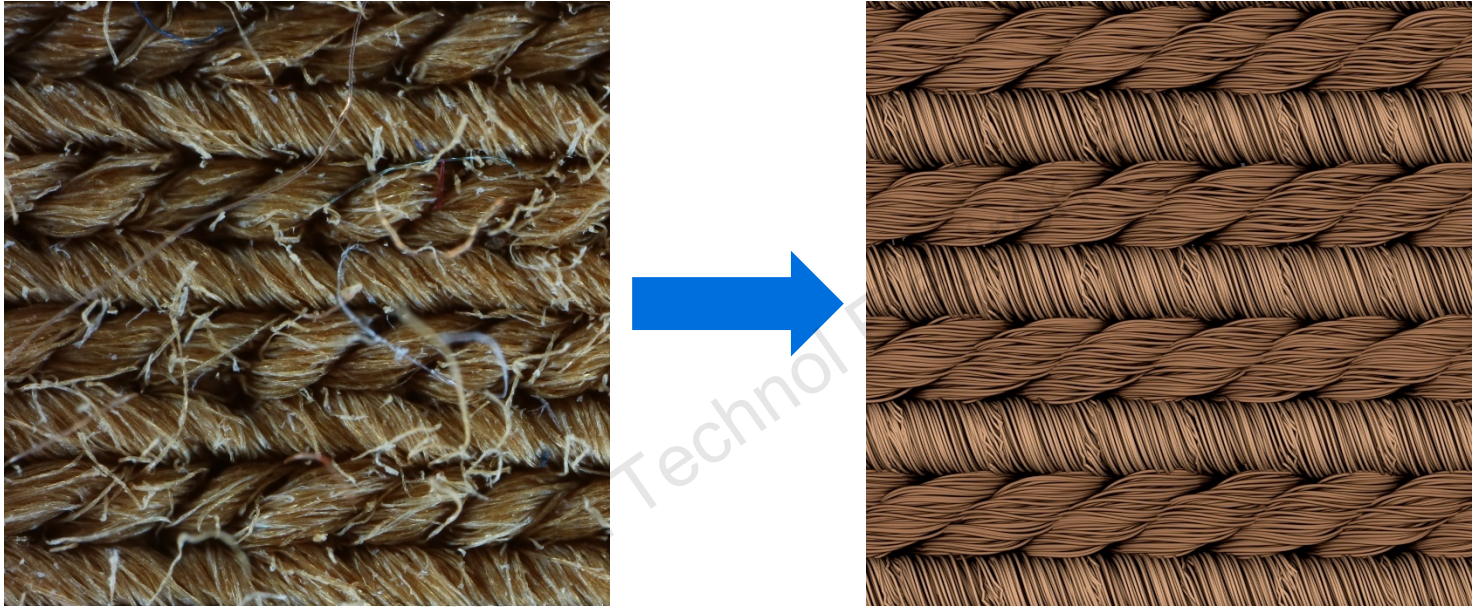
- Extremely detailed results
- Large amounts of data and massive computations



Knitting cloth

Image-based modeling:

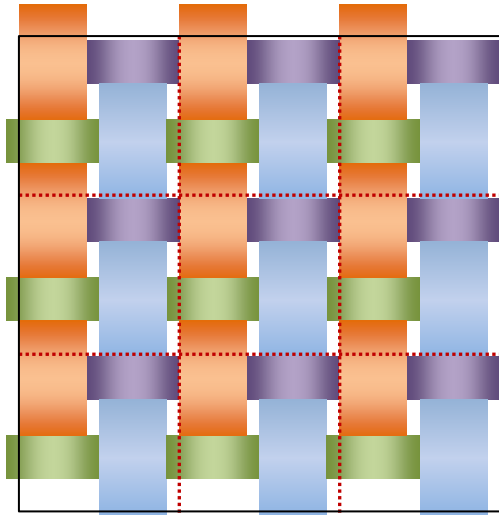
- **Tatting cloth:** the yarns are perpendicular to each other
- **Knitting cloth:** the yarns are not perpendicular to each other



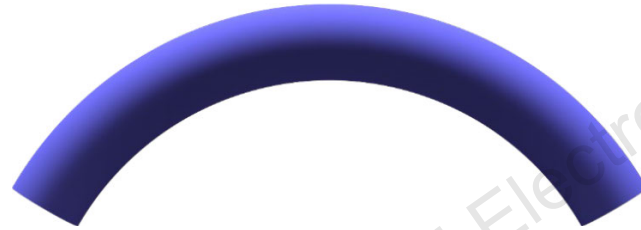
Yarn geometry of knitting cloth

Reconstructing the geometry from a single image

Yarn geometry model



Weave pattern



Yarn shape

[Irawan and Marschner, 2012]



Fibers

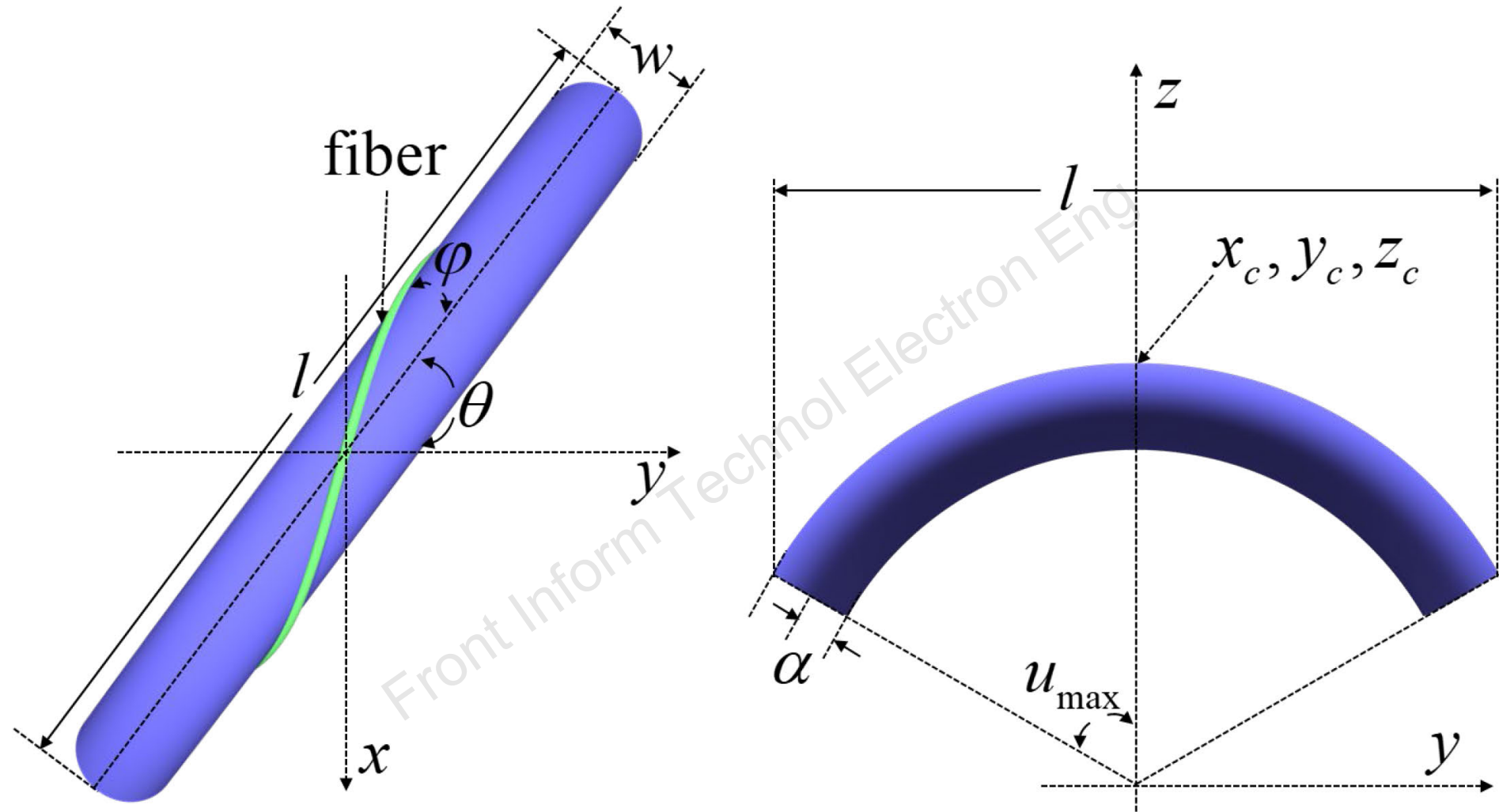
[Schröder *et al.*, 2015]

Weave pattern: spatial yarn segment layout **on cloth surface**

Yarn shape: the outer shape of yarn, modeled by curved cylinder

Fibers: a yarn is made by twisting the fibers together

Yarn geometry model (Cont'd)

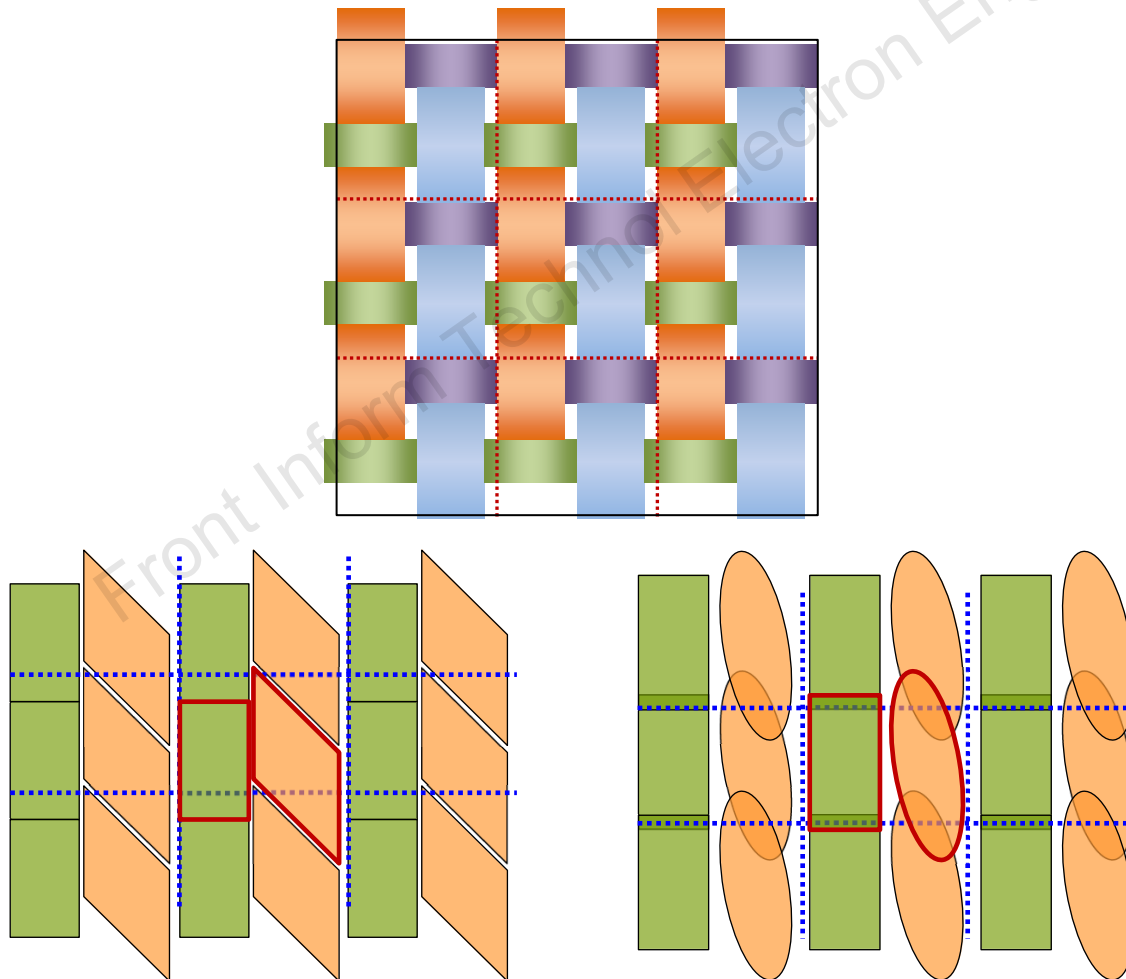


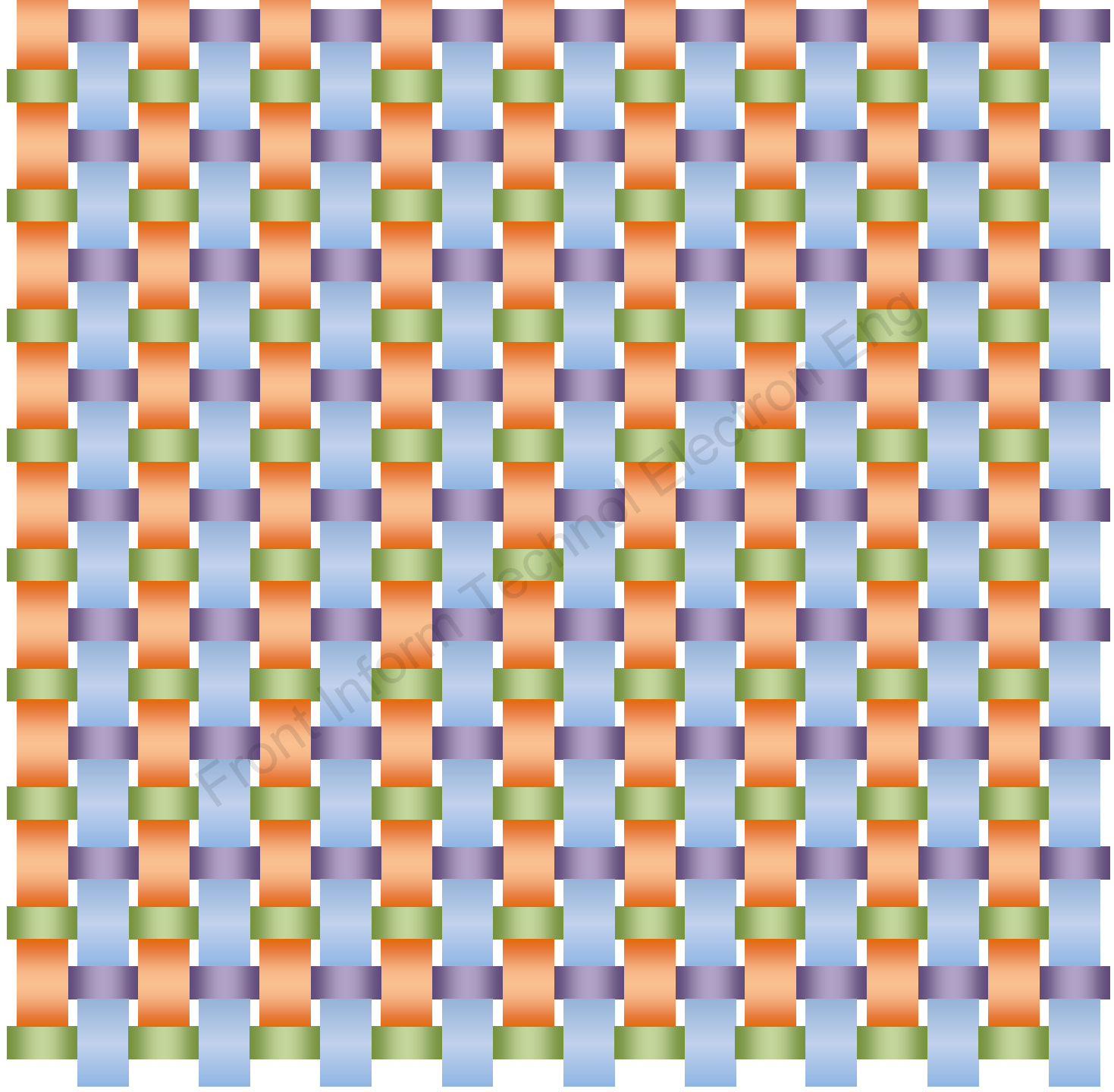
More information can be found in Irawan and Marschner (2012) and Schröder et al. (2015)

Yarn geometry model (Cont'd)

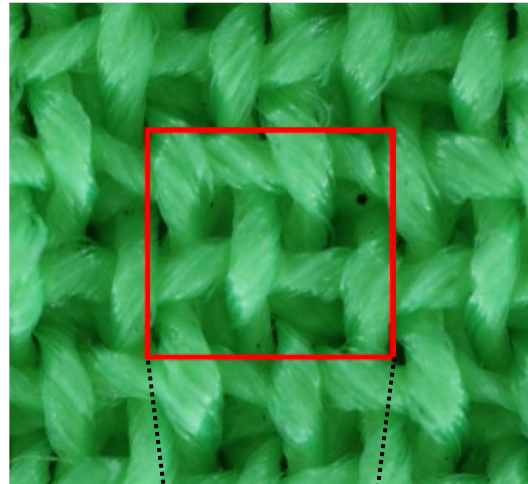
Cloth surface is a periodic texture

How to model the periodicity of the weave pattern?

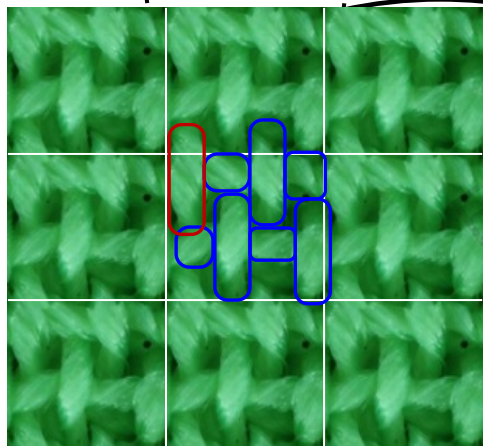
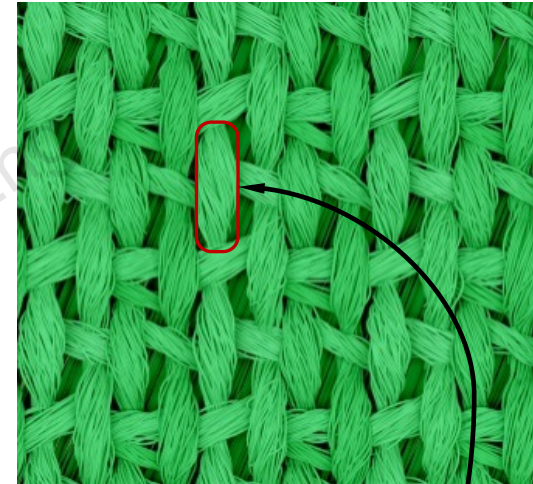




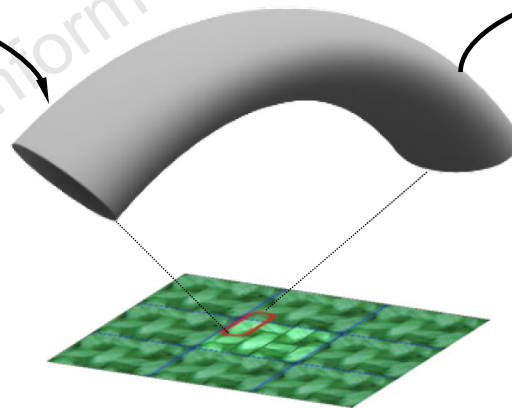
Single micro-image



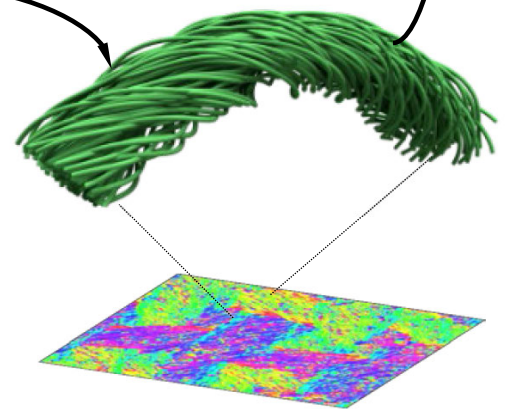
Yarn-level geometry



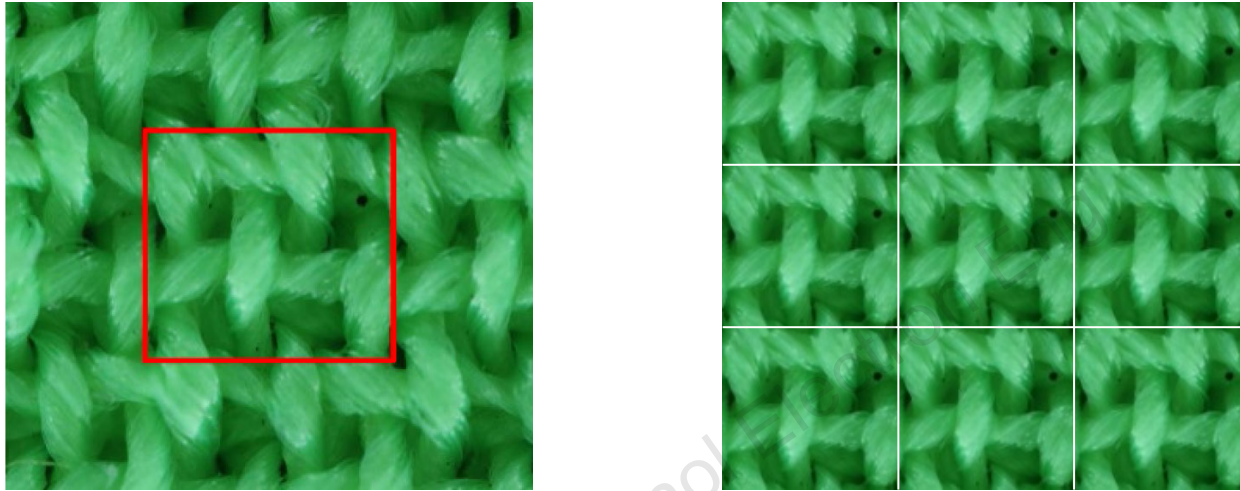
Yarn layout estimation



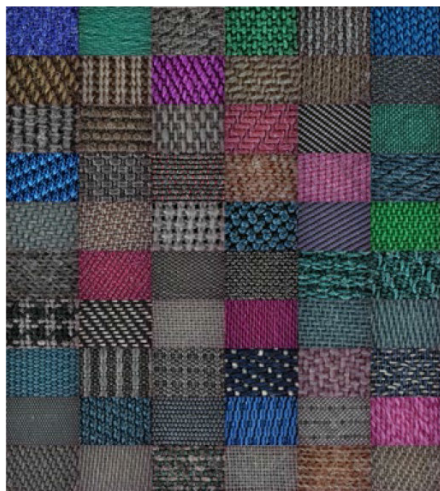
Yarn shape estimation



Fiber generation

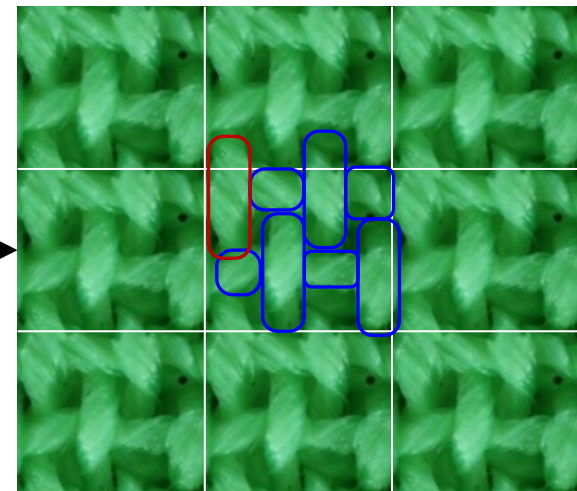


Periodic pattern detection [Asha *et al.*, 2012]

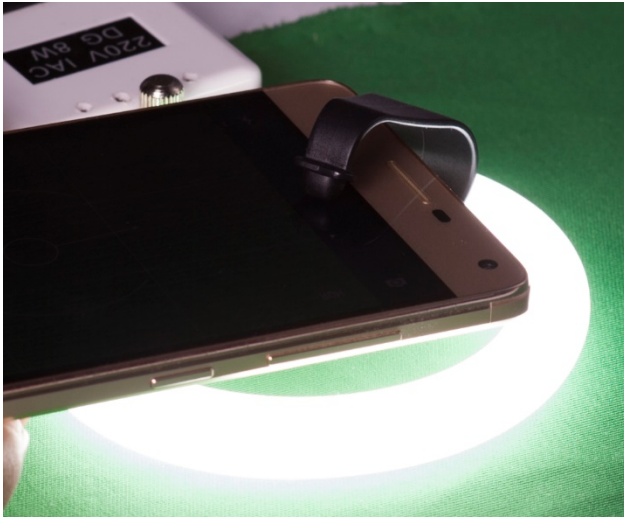


Yarn detector (DPM)

[Felzenszwalb *et al.*, 2010]



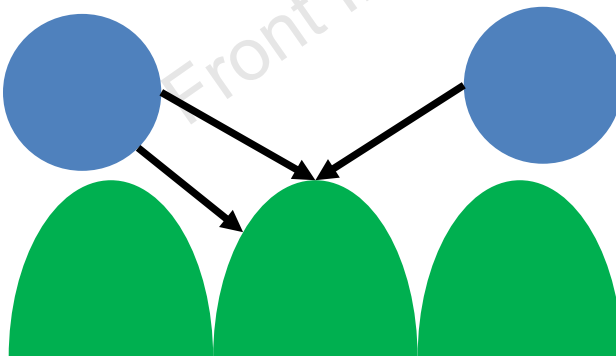
Yarn shape estimation



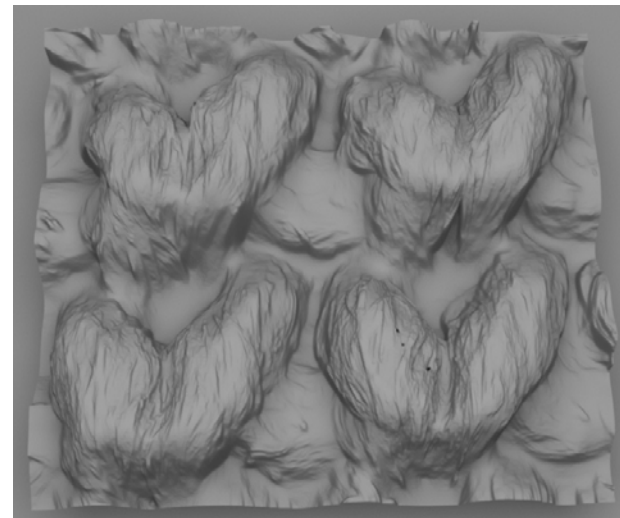
(a) Capture a single image under circular CFL light



(b) Captured image



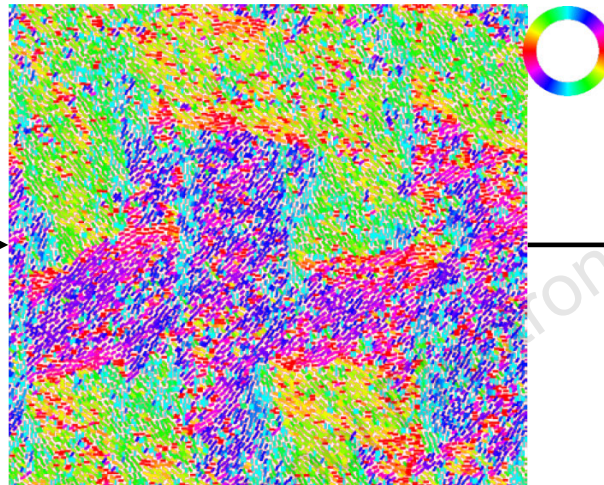
Dark is deep



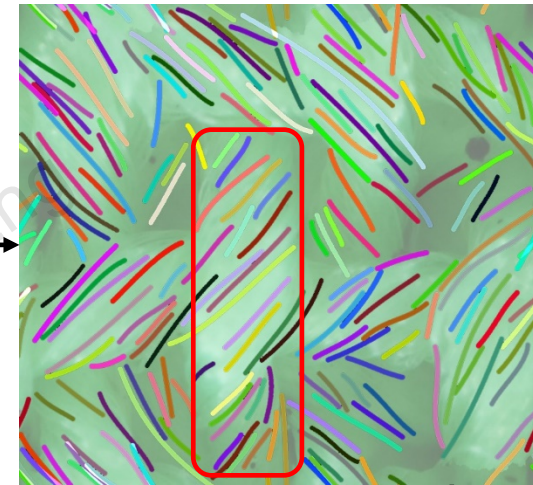
(c) Depth from image intensity



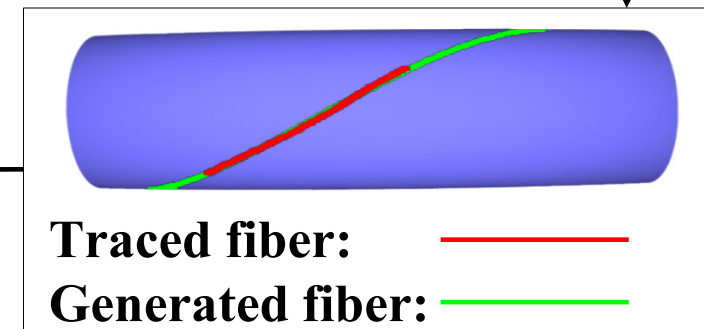
(a) Unit patch



(b) Discretized orientation map



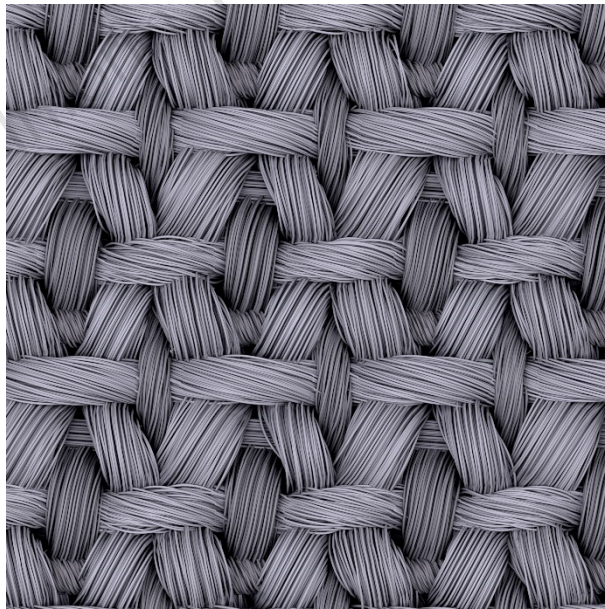
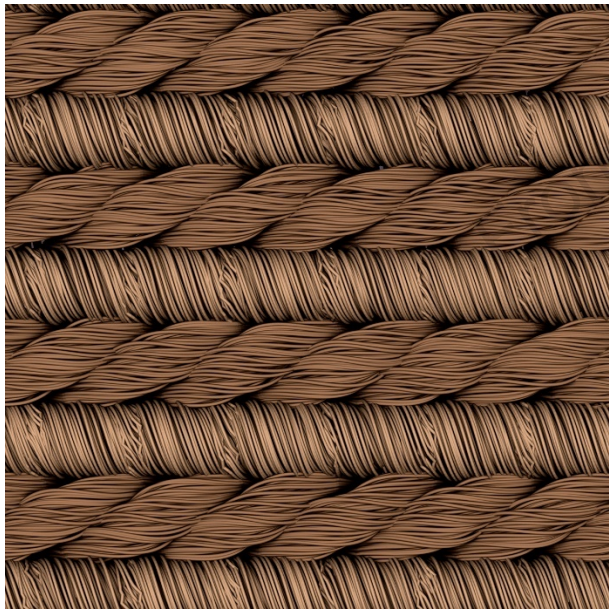
(c) Fiber tracing

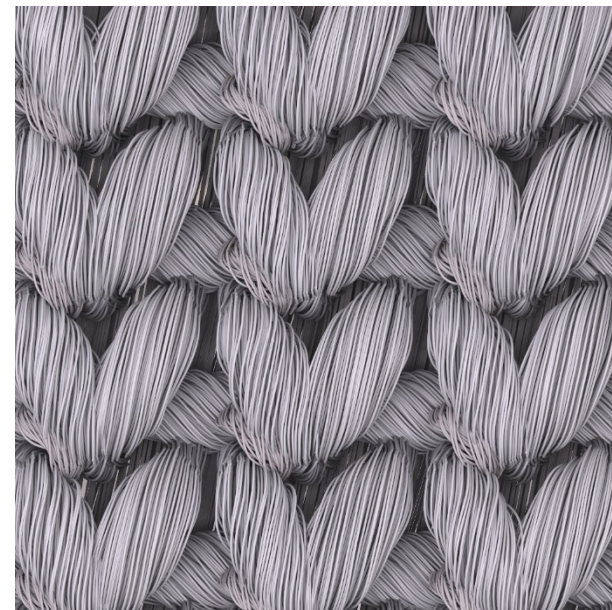
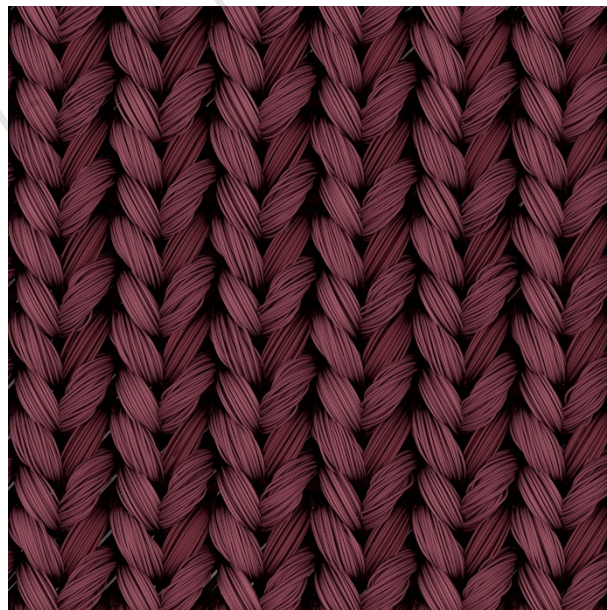


(d) Fiber fitting

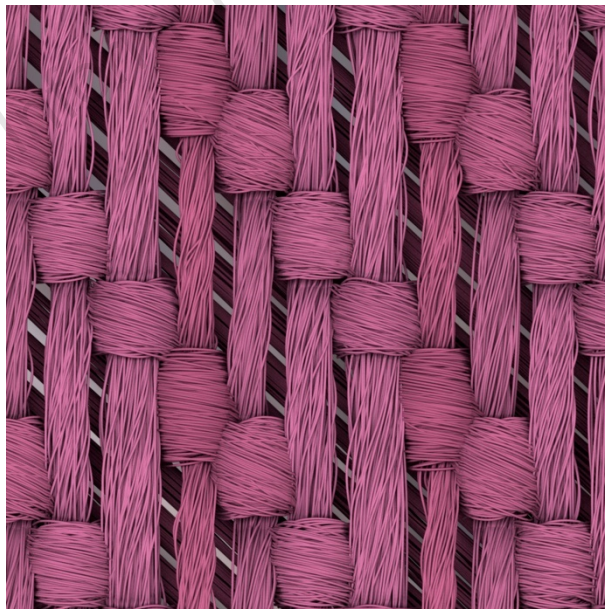
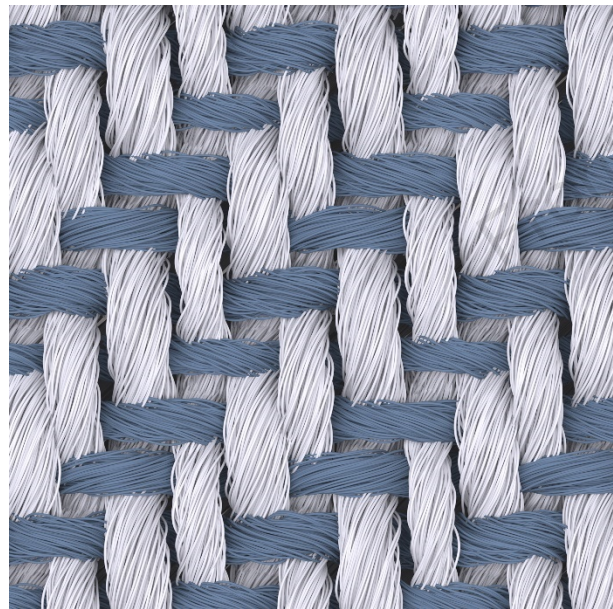


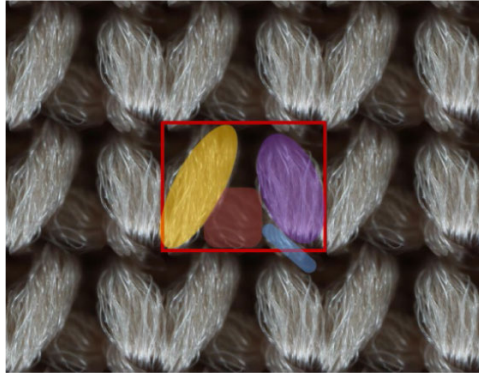
(e) Fiber generation



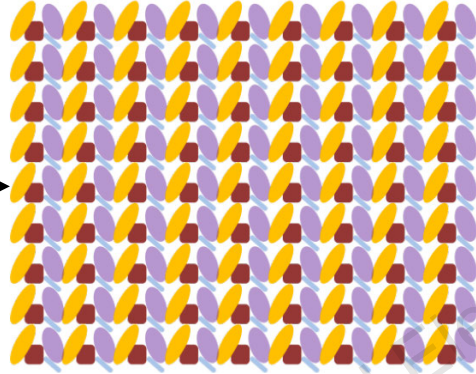


Results (Cont'd)

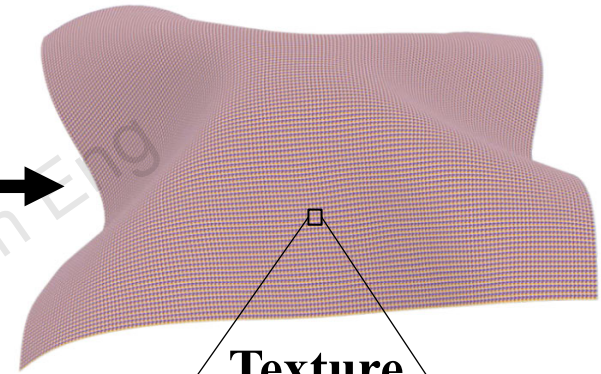




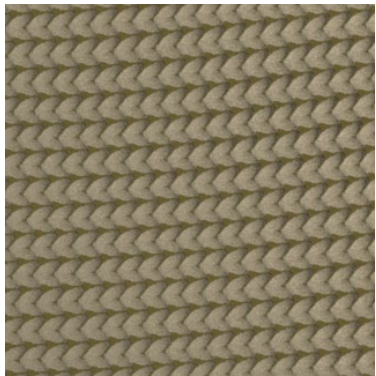
Yarn layout & geometry



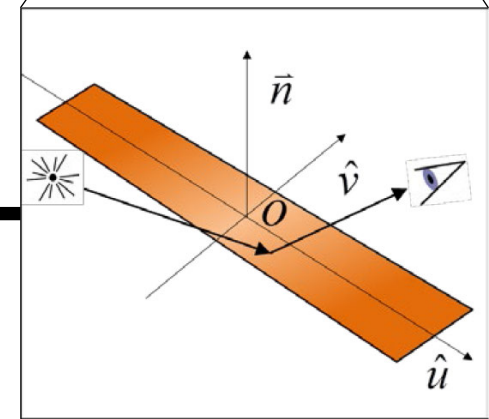
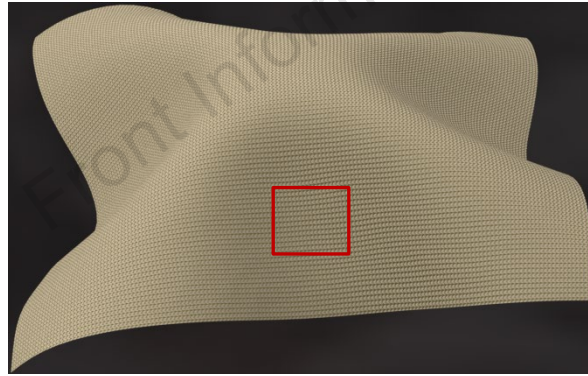
Periodic texture



Texture mapping

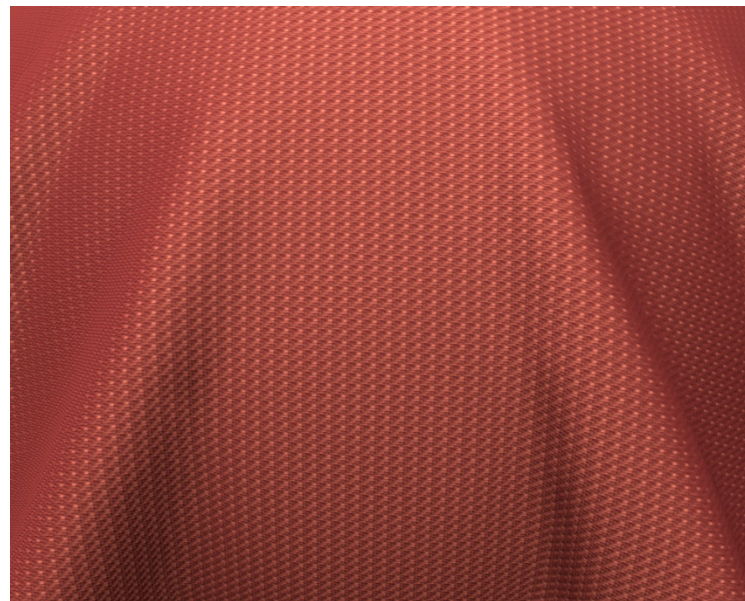
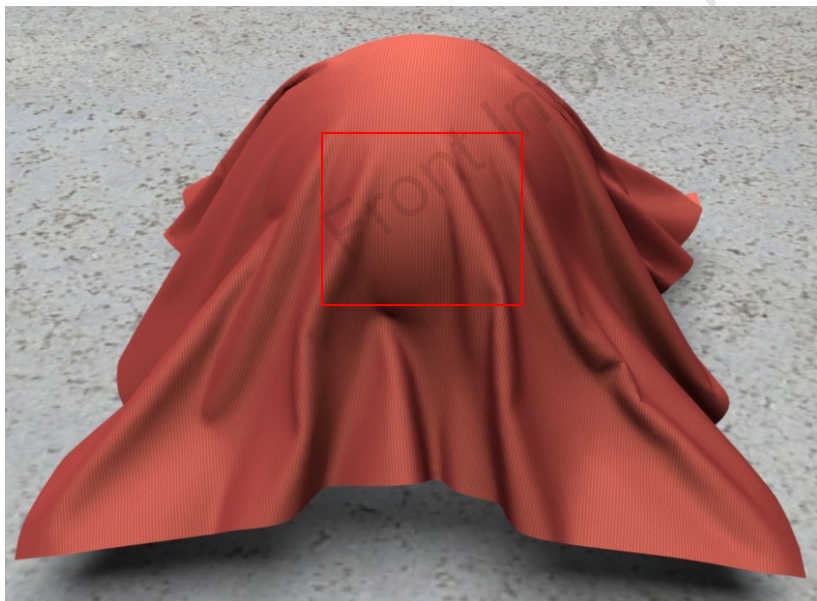
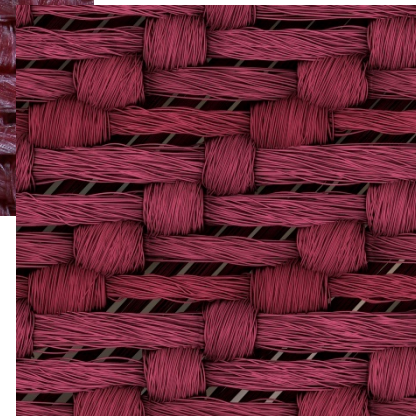


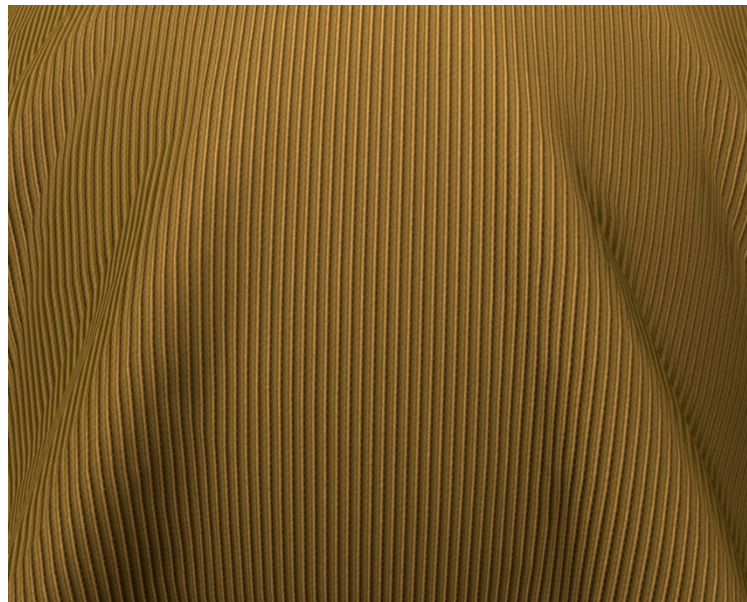
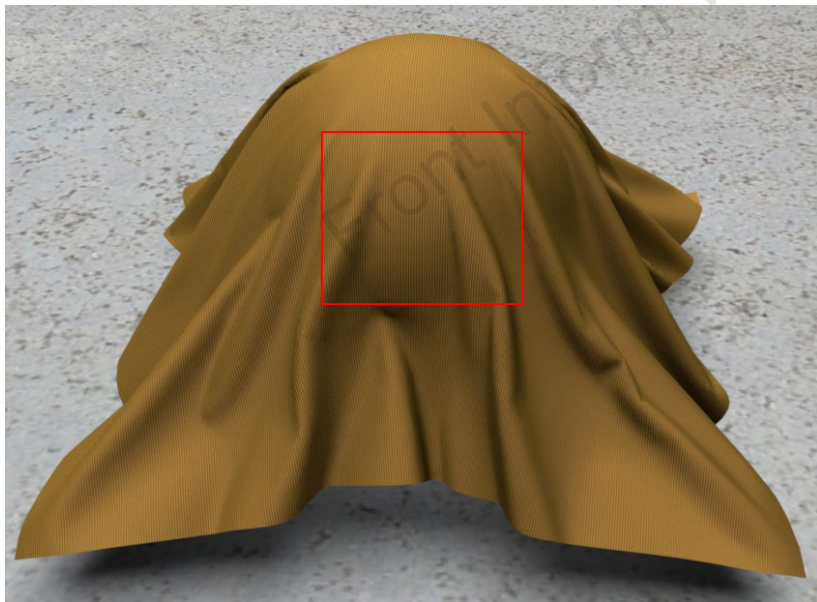
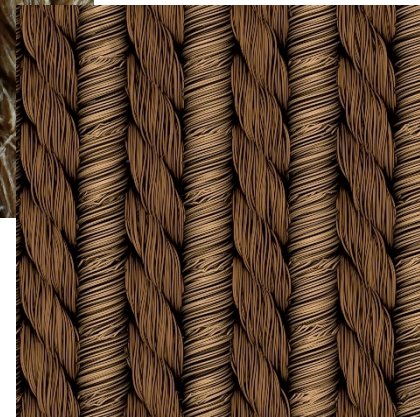
Rendering

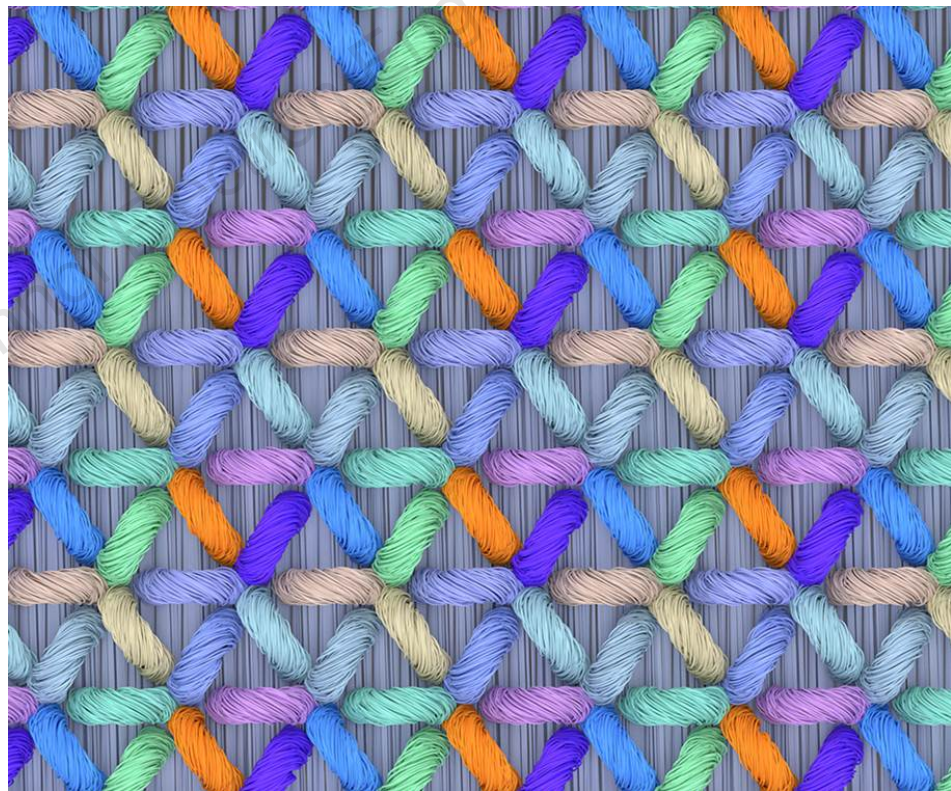
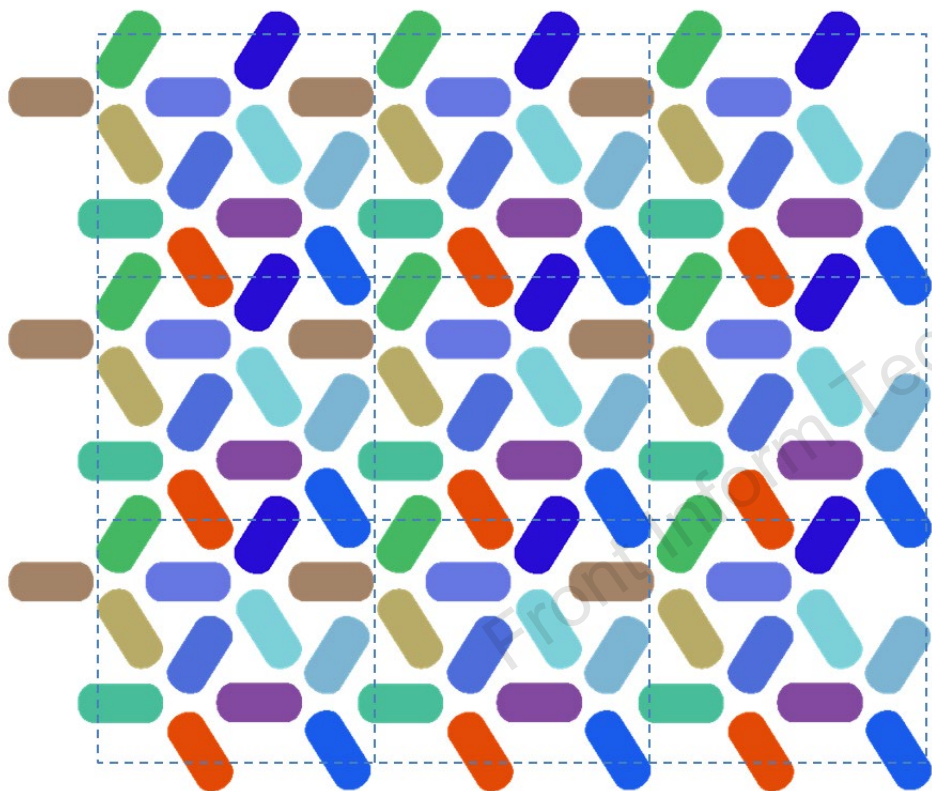


Yarn scattering model

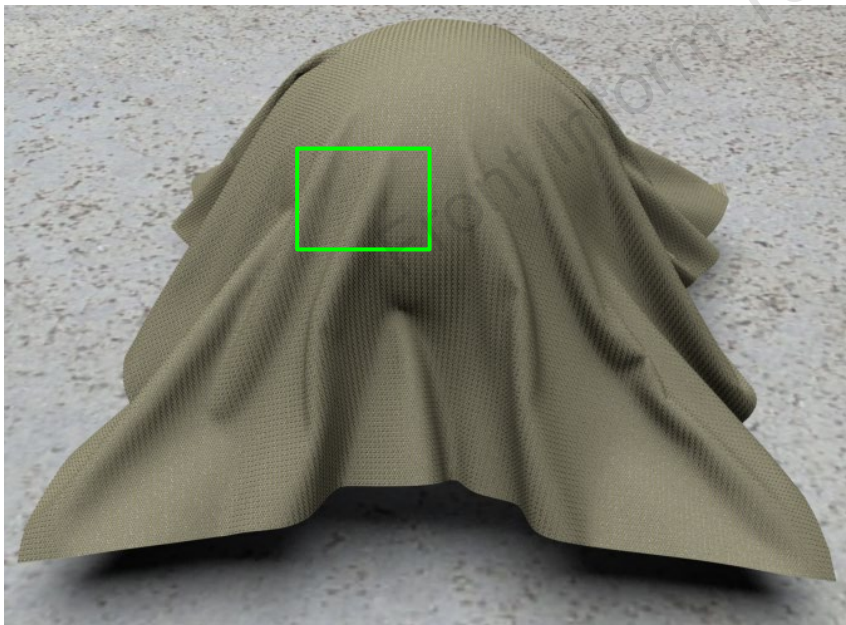
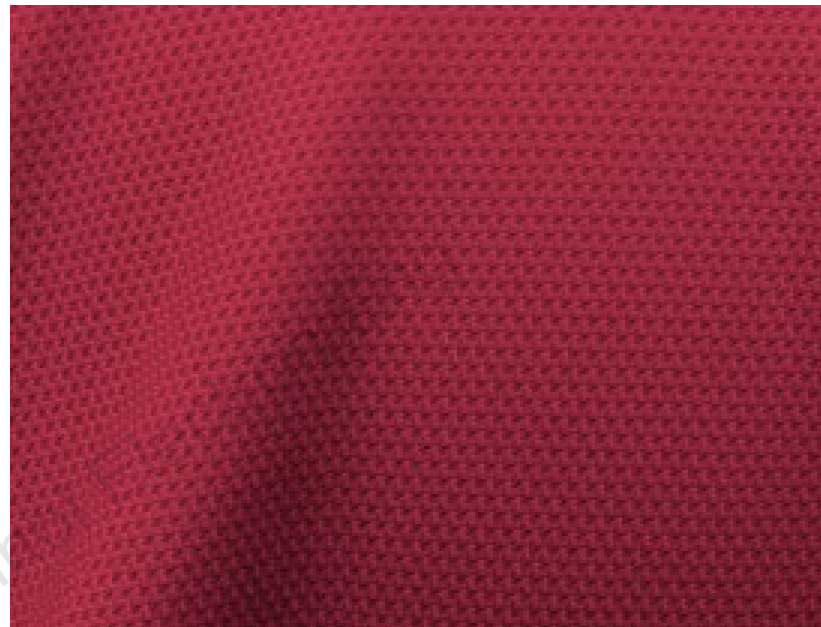
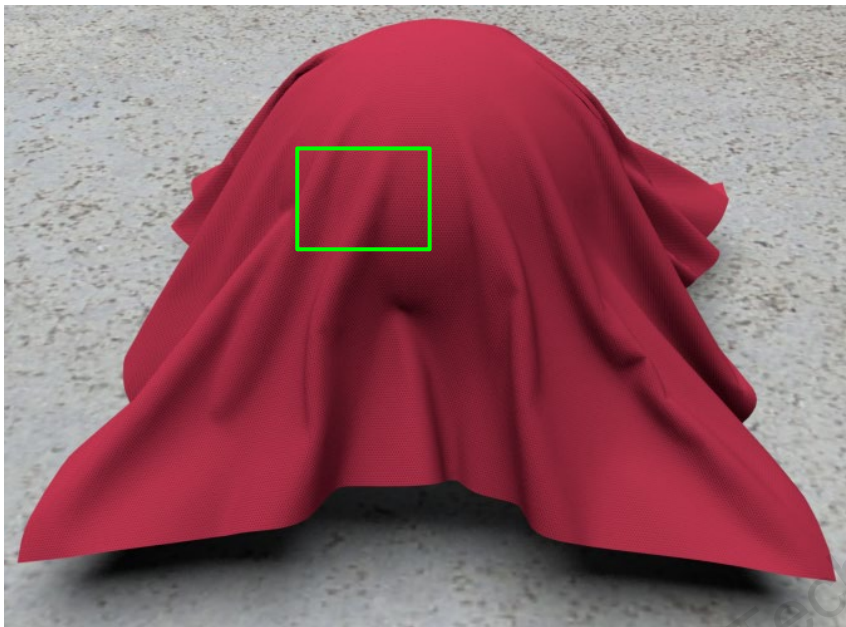
[Irawan and Marschner, 2012]



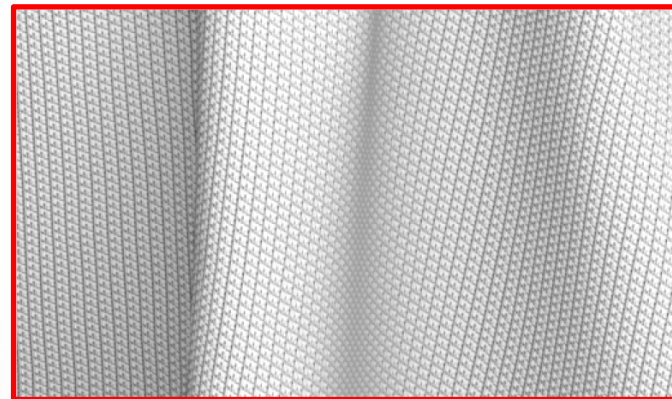
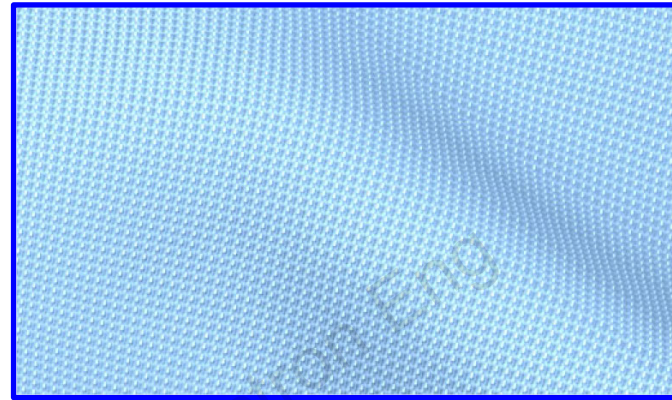
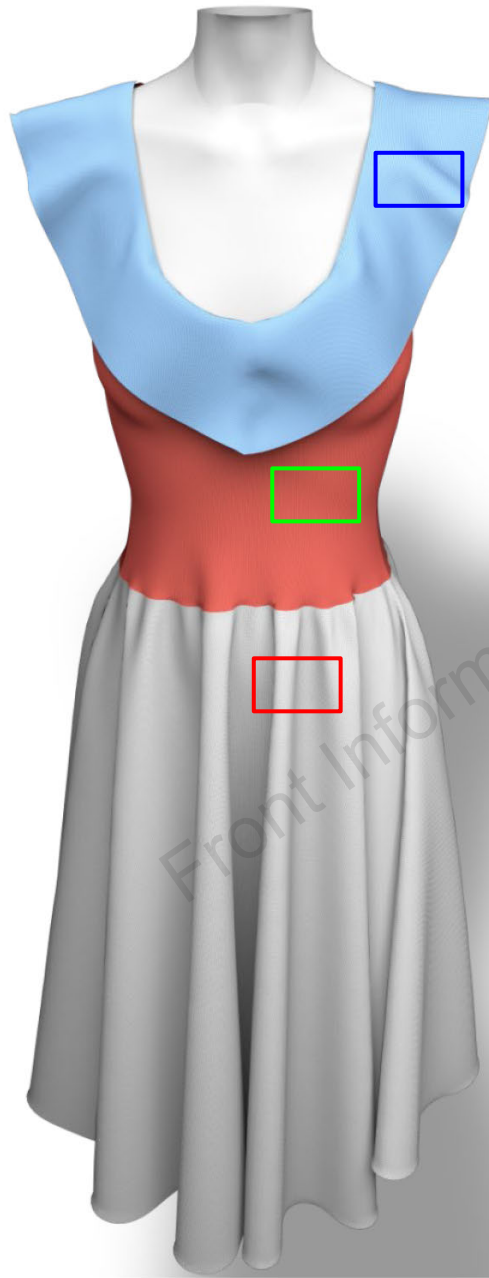




Results (Cont'd)

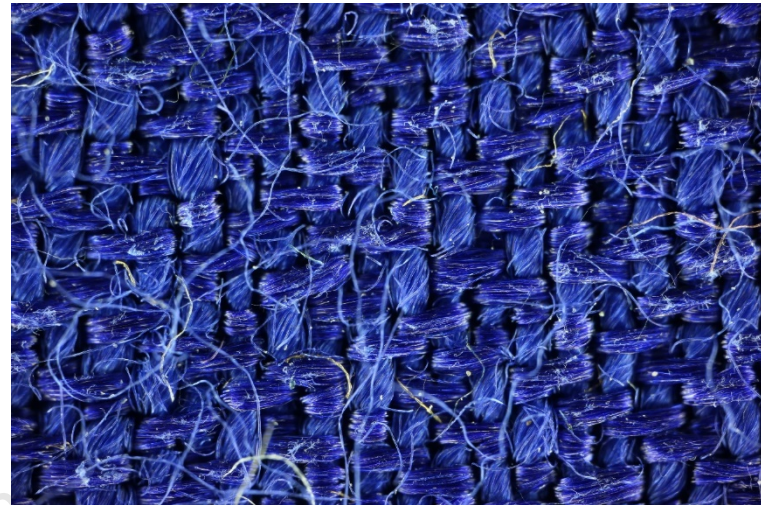


Results (Cont'd)





Non-woven cloth



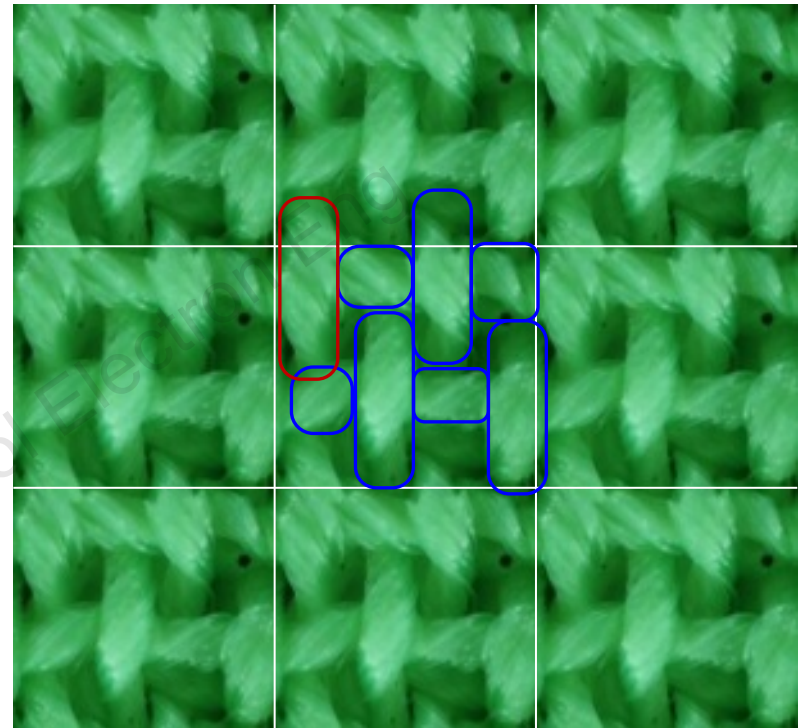
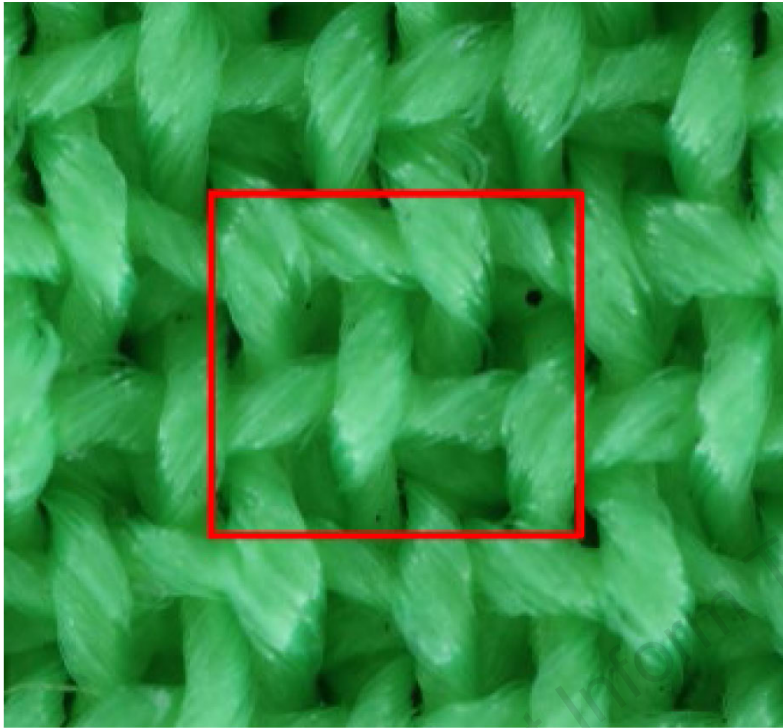
Seriously distorted



Heavy density of flyaway fibers



Transparency yarns



- Repeating pattern and yarn detection needs manual correction!
- Automatic analysis is a difficult computer vision problem, but it is useful for Internet applications.