Hong-yu WU, Xiao-wu CHEN, Chen-xu ZHANG, Bin ZHOU, Qin-ping ZHAO, 2019. Modeling yarn-level geometry from a single micro-image. *Frontiers of Information Technology & Electronic Engineering*, 20(9):1165-1174. https://doi.org/10.1631/FITEE.1800693

Modeling yarn-level geometry from a single micro-image

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

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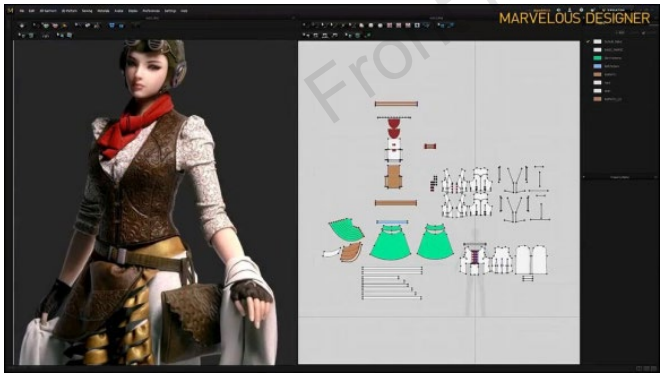
Background

Cloth rendering is important for many applications

Virtual fitting

Film production

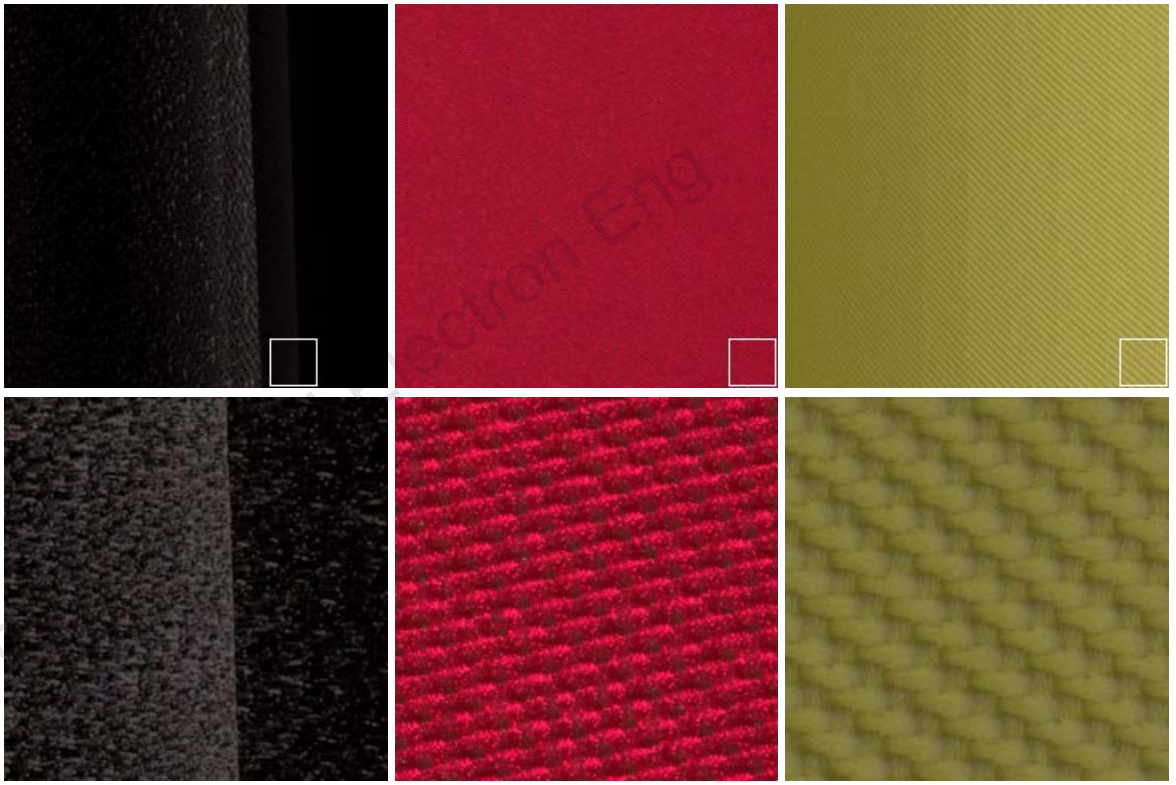


Garment design

Computer games

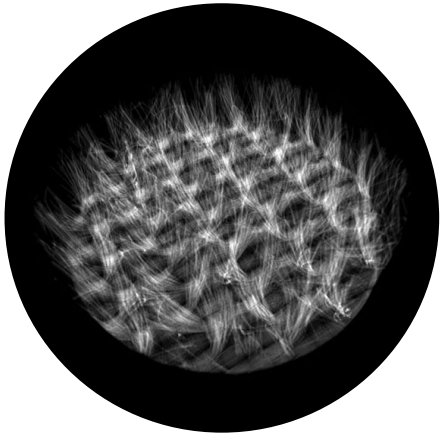
Background (Cont'd)

[Khungurn *et al.*, 2015]



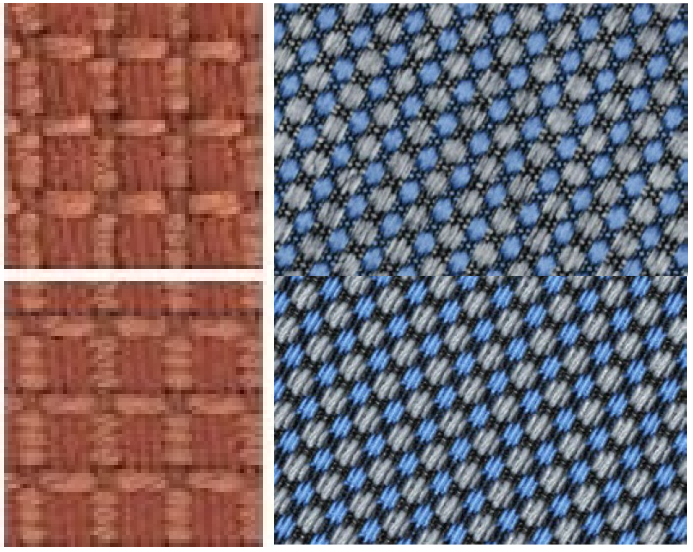
Yarn struct is crucial to photo realistic rendering of cloth!

Related work




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]

Related work (Cont'd)

Knitting cloth

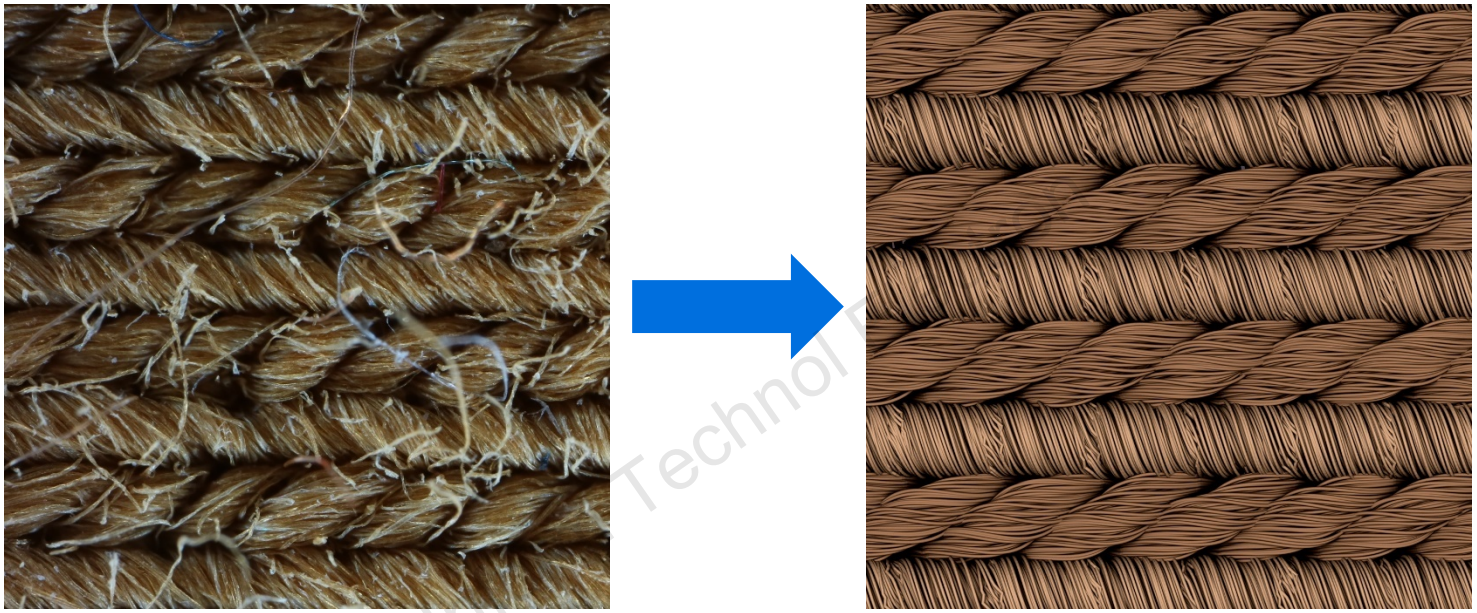
Volume-based:

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

Image-based modeling:

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

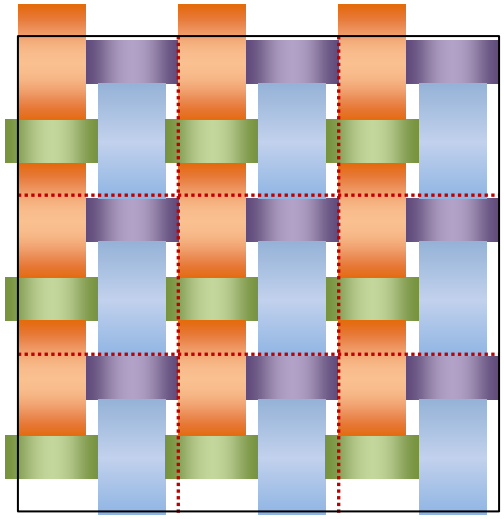
Motivation



Yarn geometry of knitting cloth

Reconstructing the geometry from a single image

Yarn geometry model



Weave pattern

Yarn shape
[Irawan and Marschner, 2012]

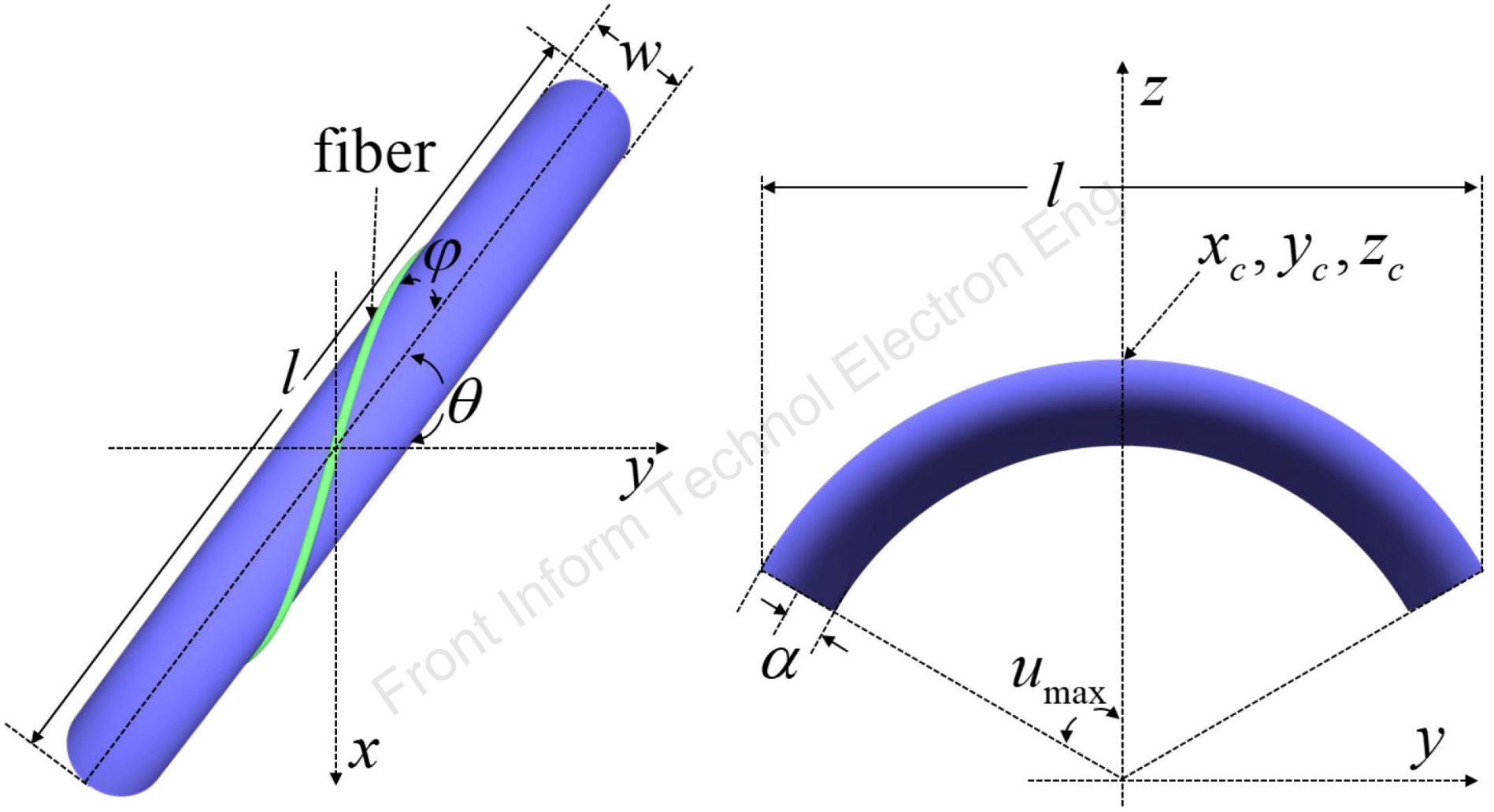
Fibers
[Schröder *et al.*, 2015]

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)

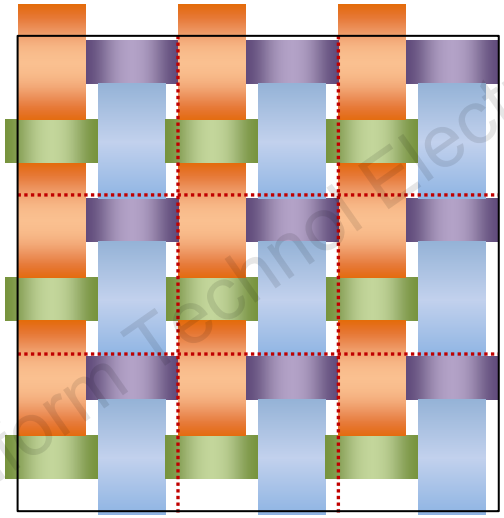


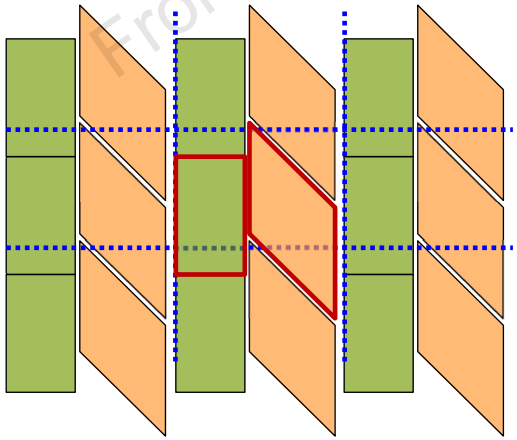
More information can be found in Irawan and Marschner (2012) and Schröder et al. (2015)

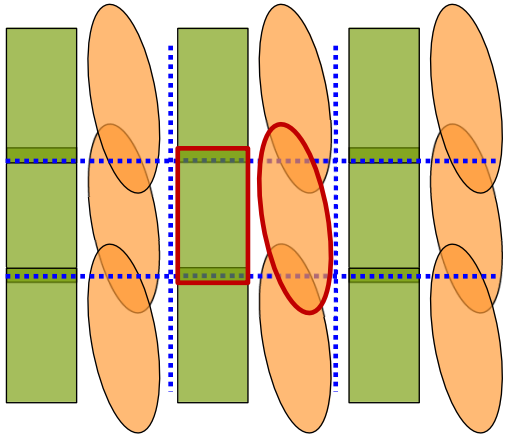
Yarn geometry model (Cont'd)

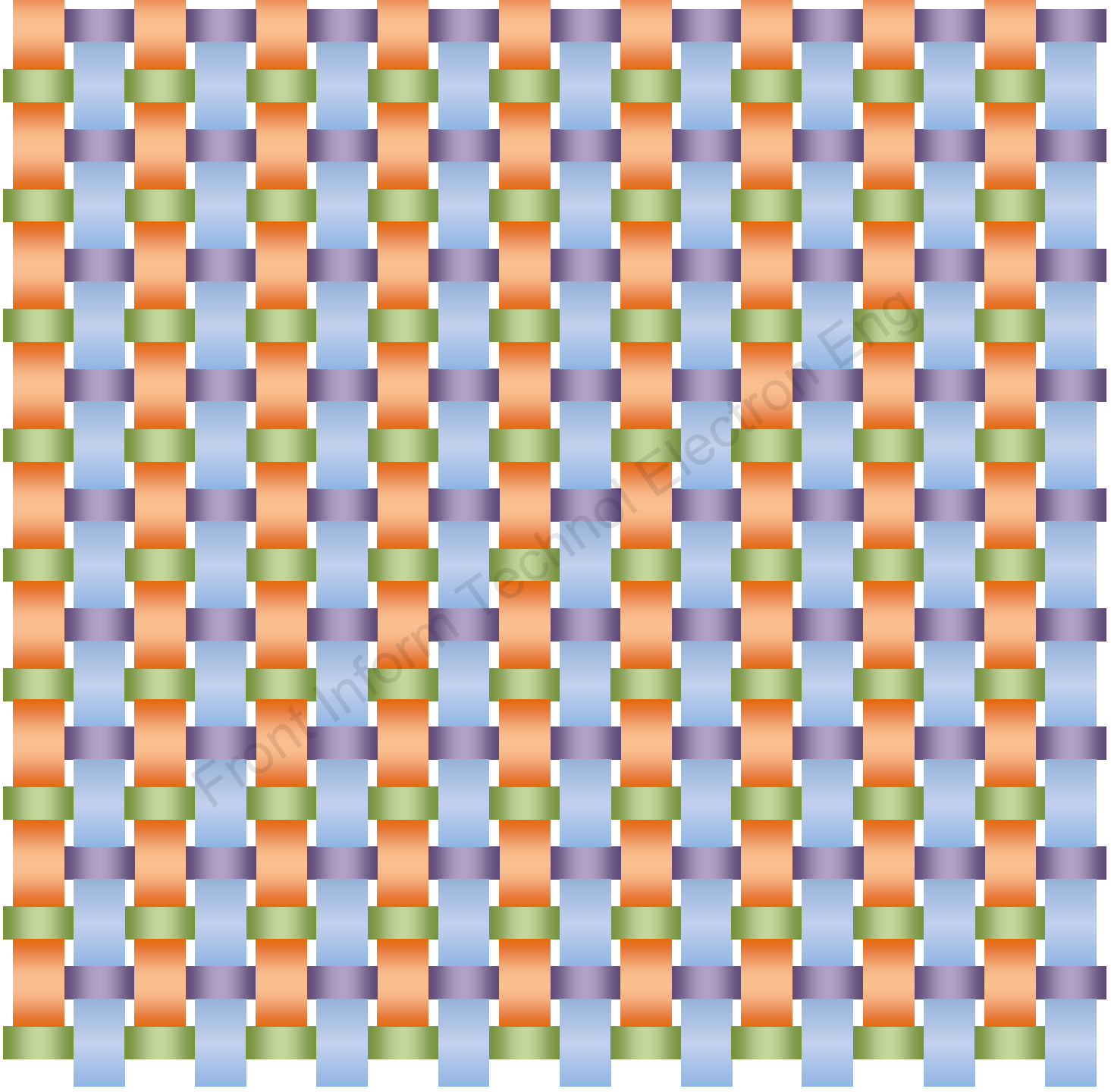
Cloth surface is a periodic texture

How to model the periodicity of the weave pattern?



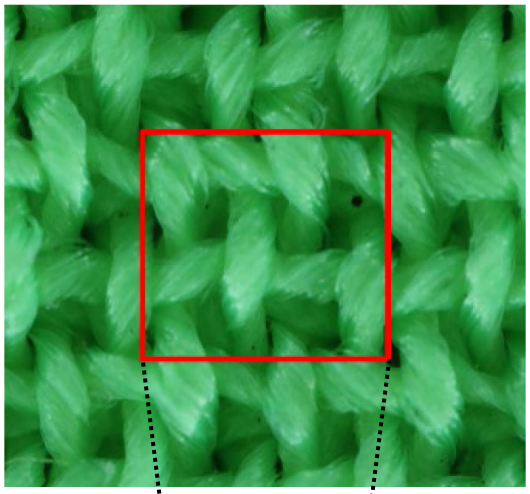


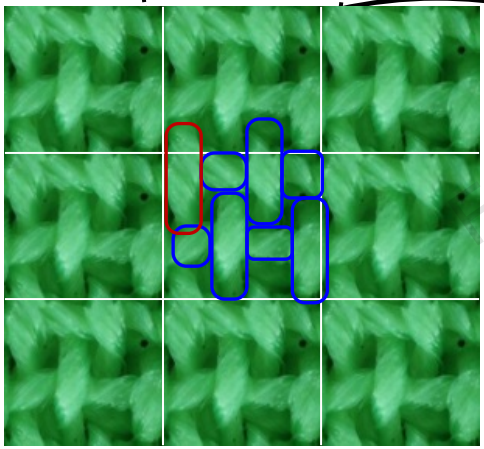




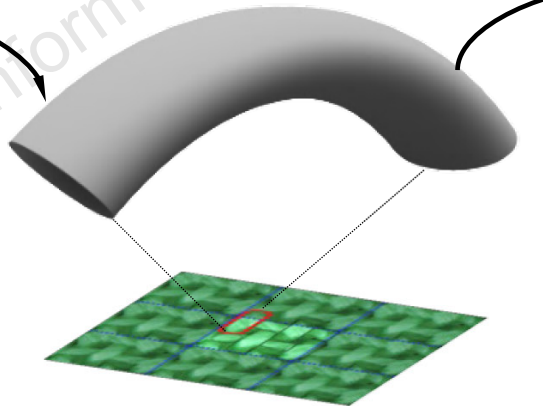
Pipeline

Single micro-image



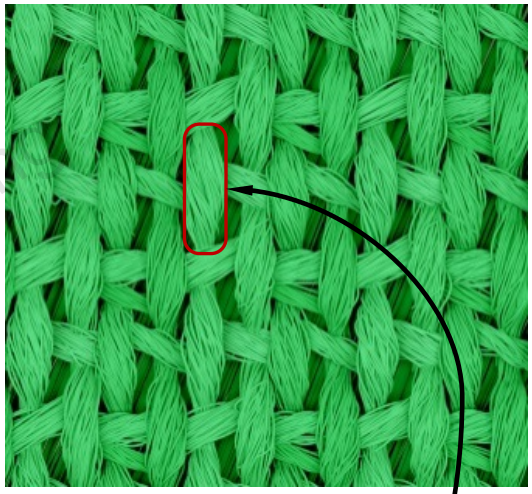


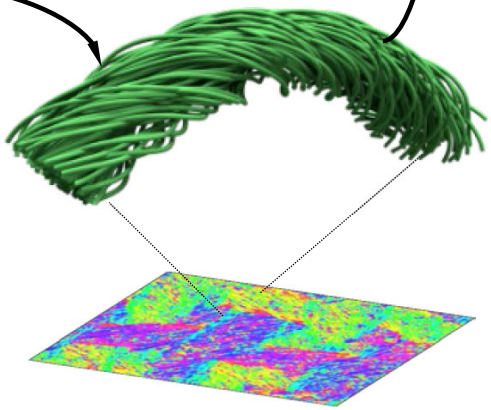
Yarn layout estimation



Yarn shape estimation

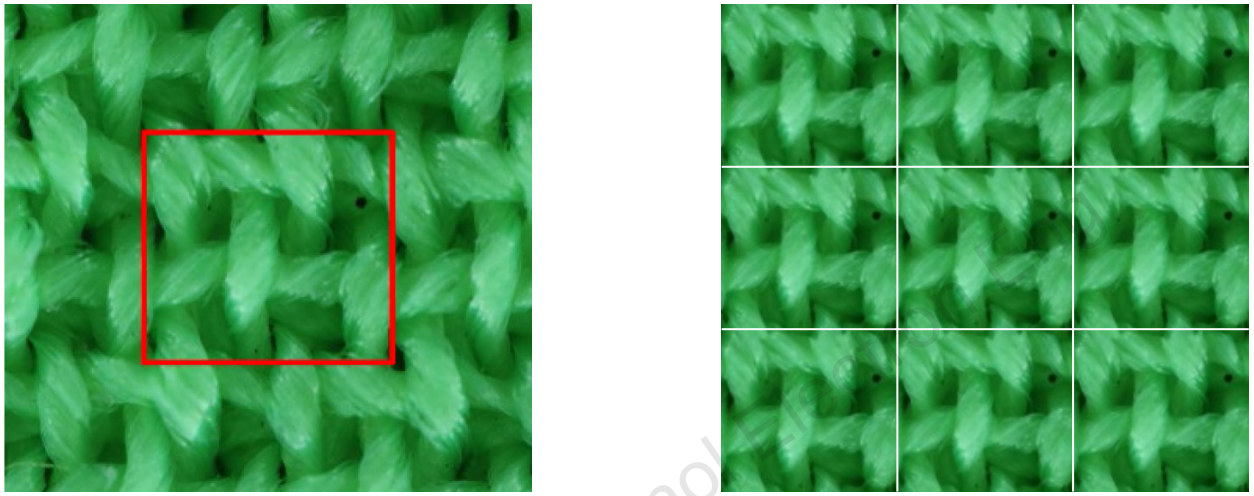
Yarn-level geometry



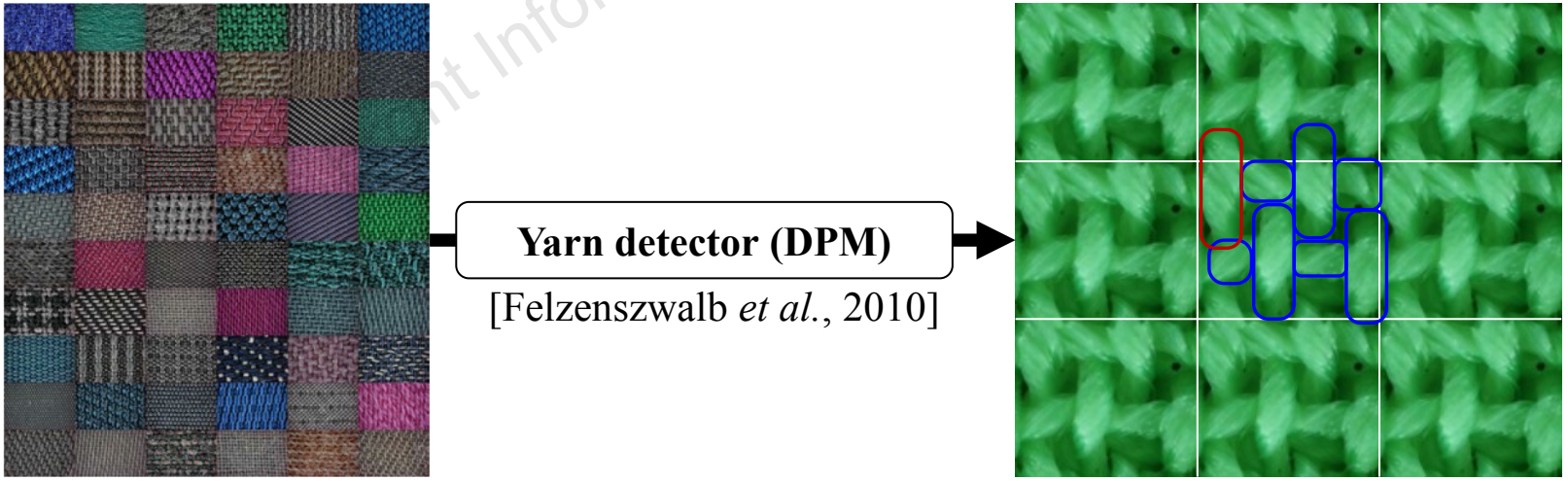


Fiber generation

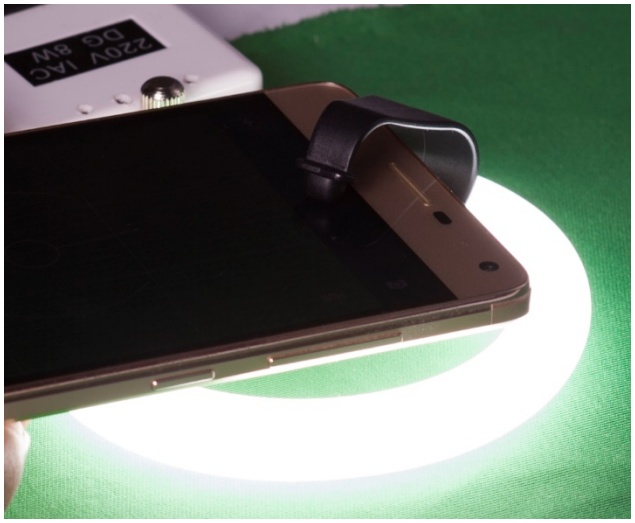
Yarn layout estimation



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

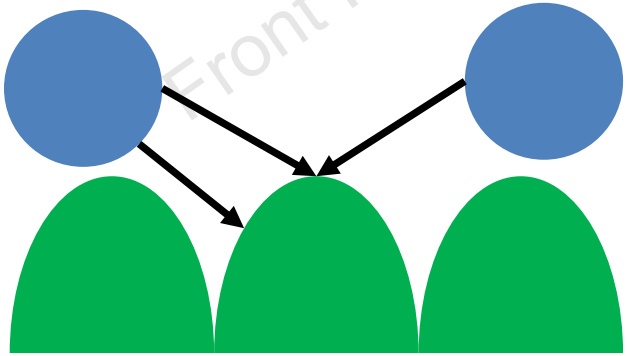


Yarn shape estimation

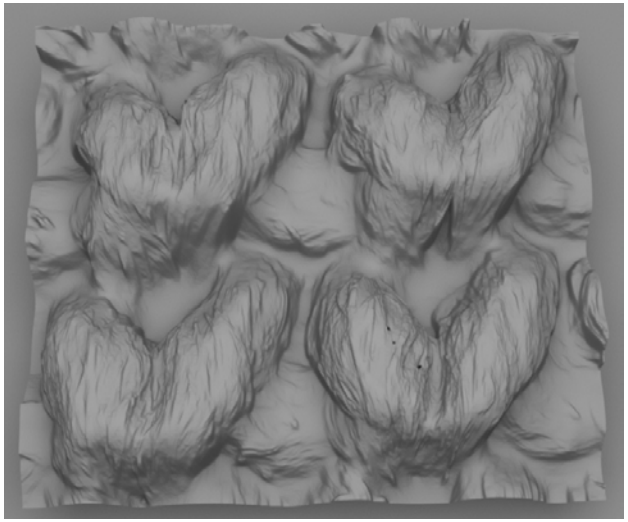


(a) Capture a single image under circular CFL light

(b) Captured image



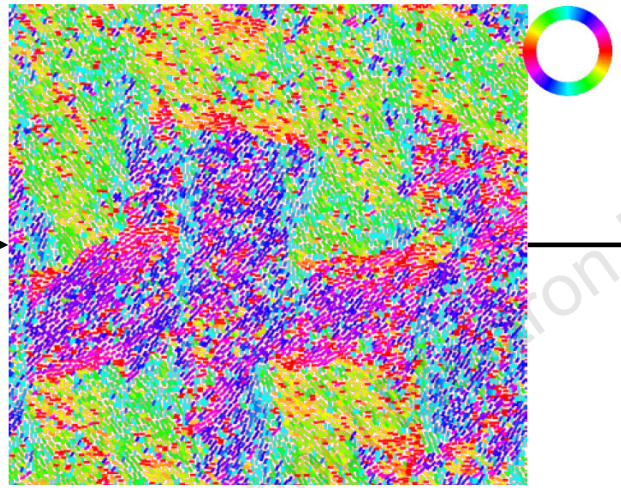
Dark is deep



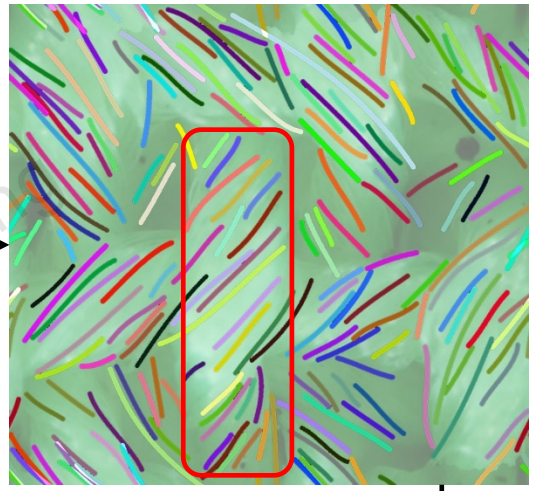
(c) Depth from image intensity

Fiber generation

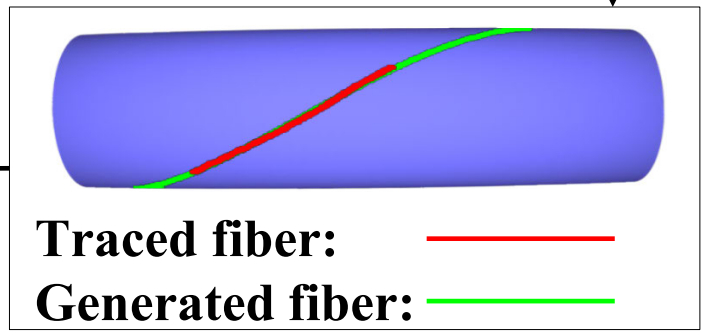
(a) Unit patch



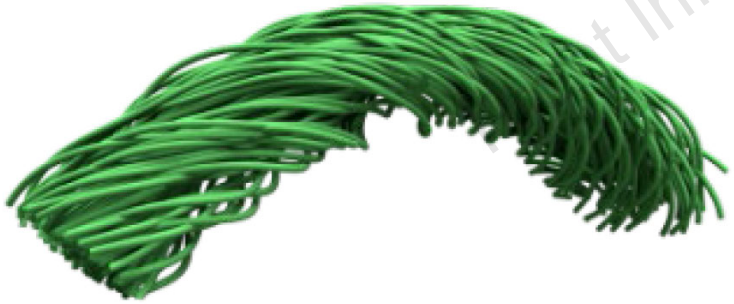
(b) Discretized orientation map



(c) Fiber tracing



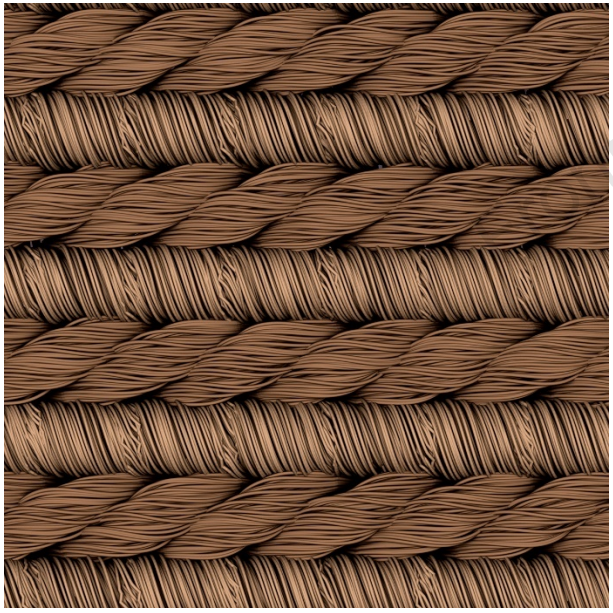
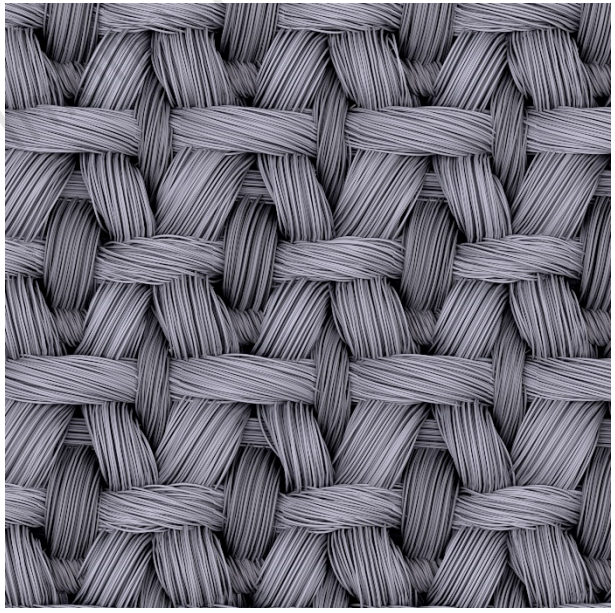
(d) Fiber fitting



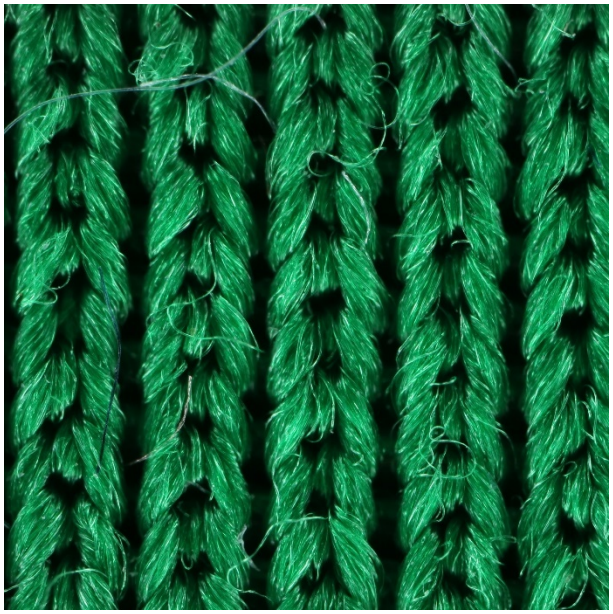
(e) Fiber generation

Results

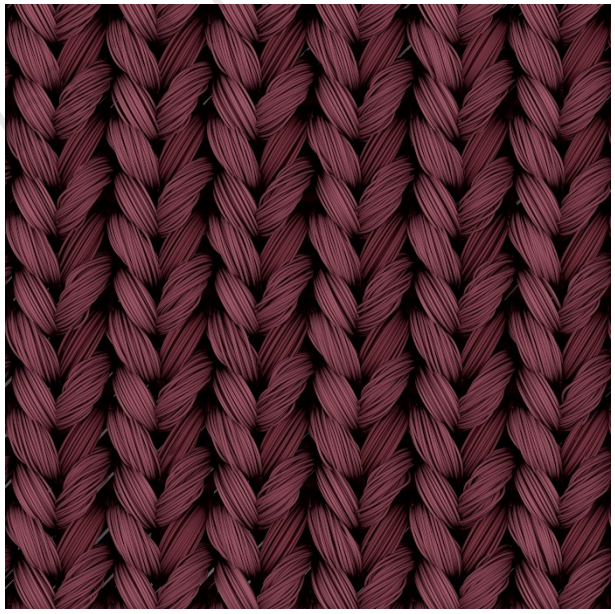
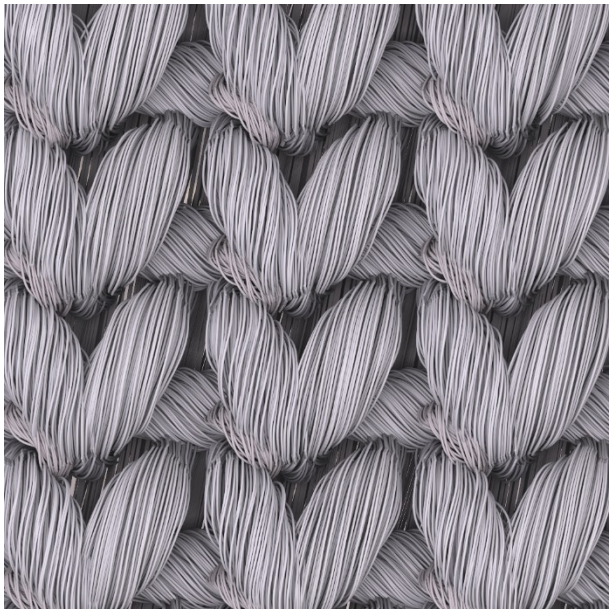



Results (Cont'd)

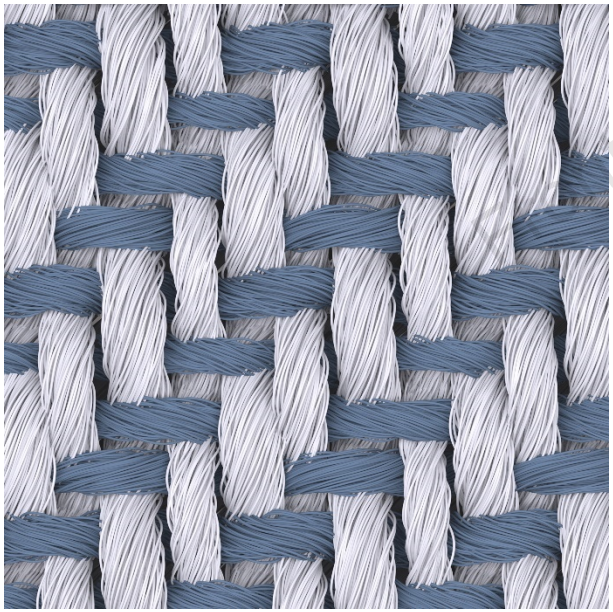
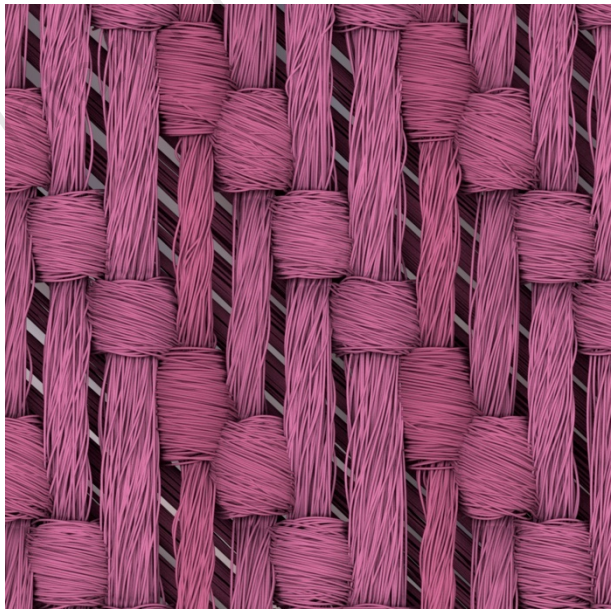




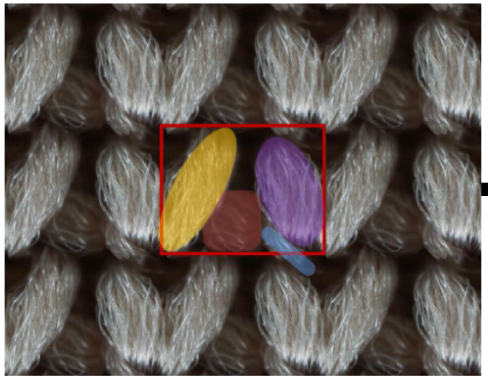



Results (Cont'd)

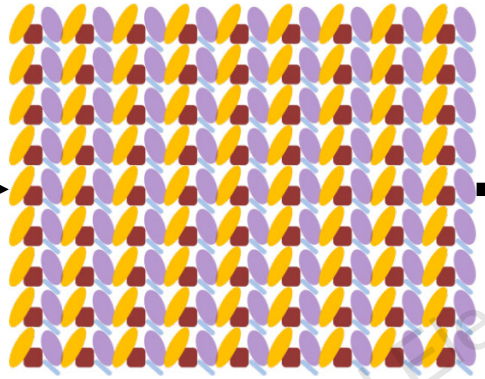


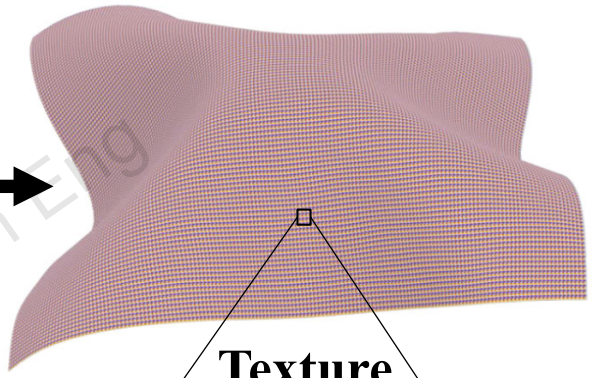

Results (Cont'd)



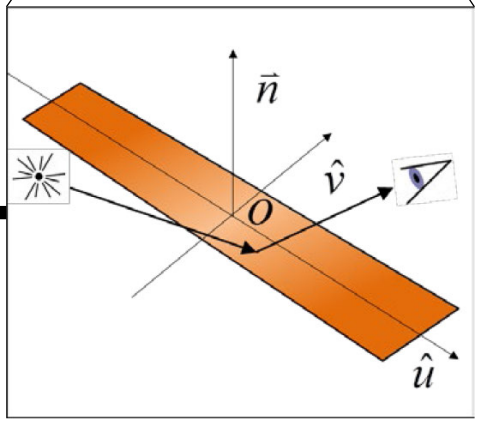
Yarn layout & geometry



Periodic texture

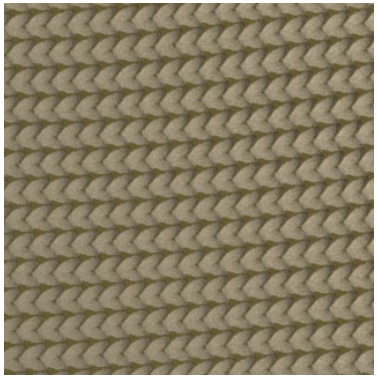


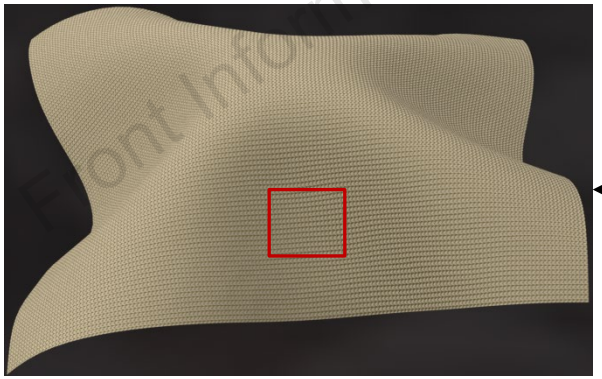
Texture mapping



Yarn scatting model

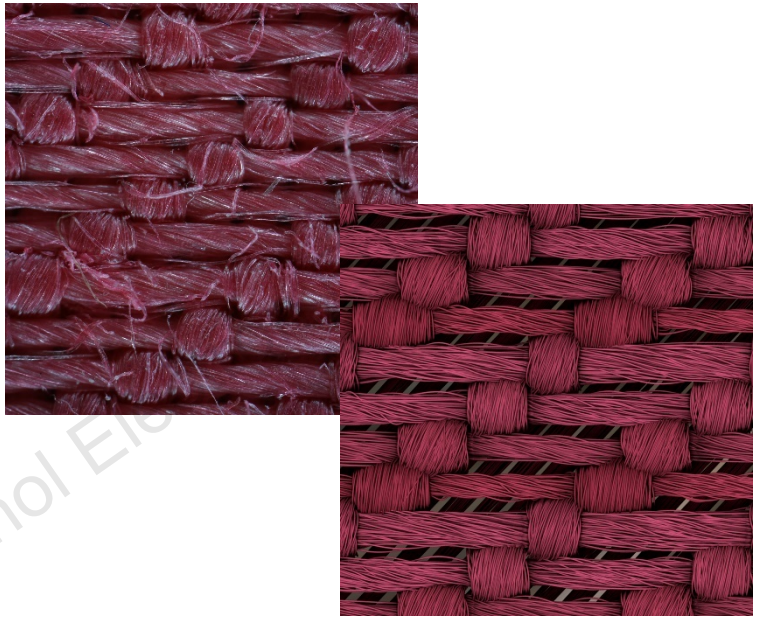
[Irawan and Marschner, 2012]

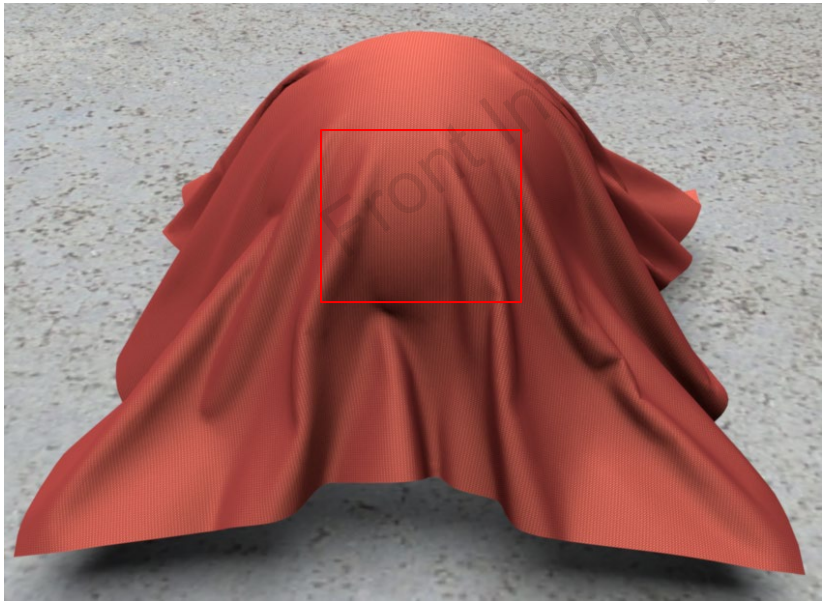


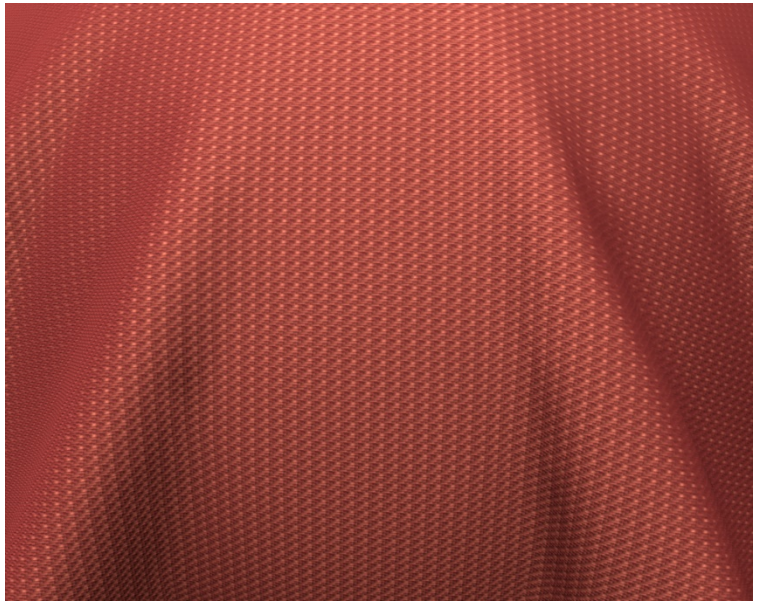


Rendering

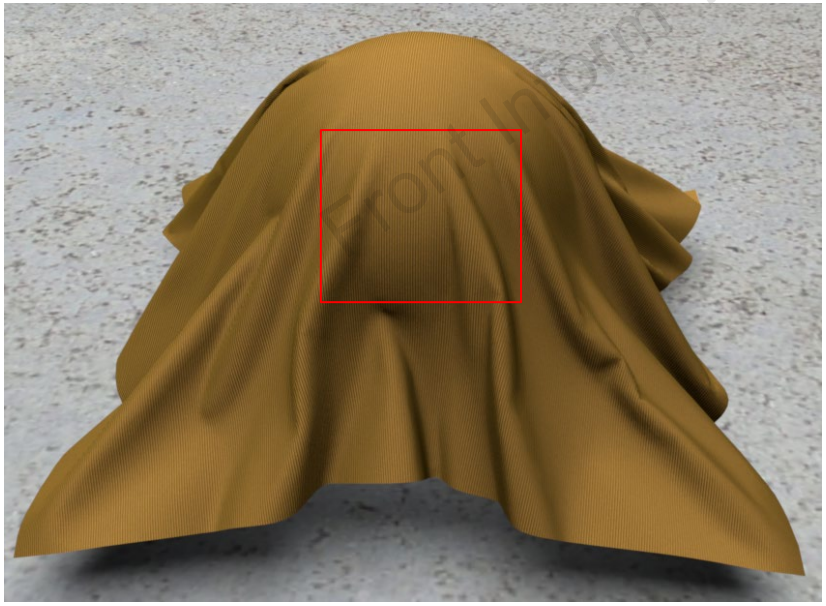
Results (Cont'd)

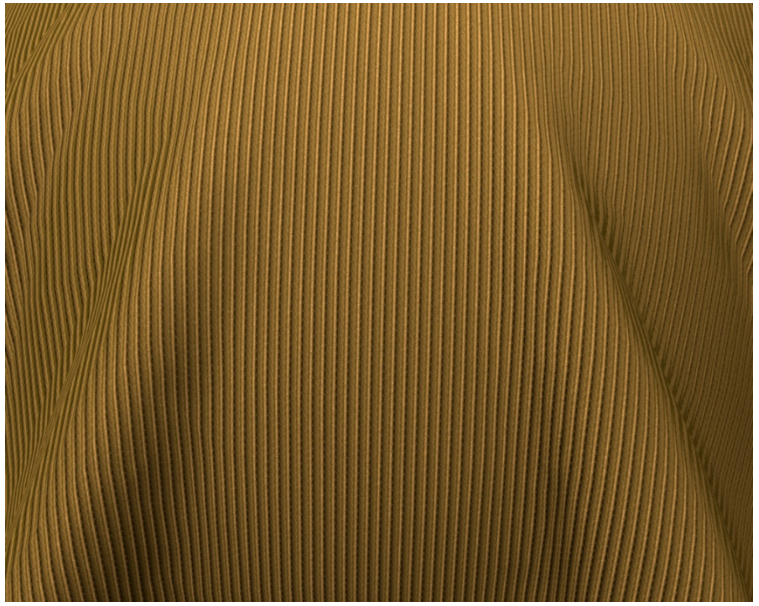






Results (Cont'd)





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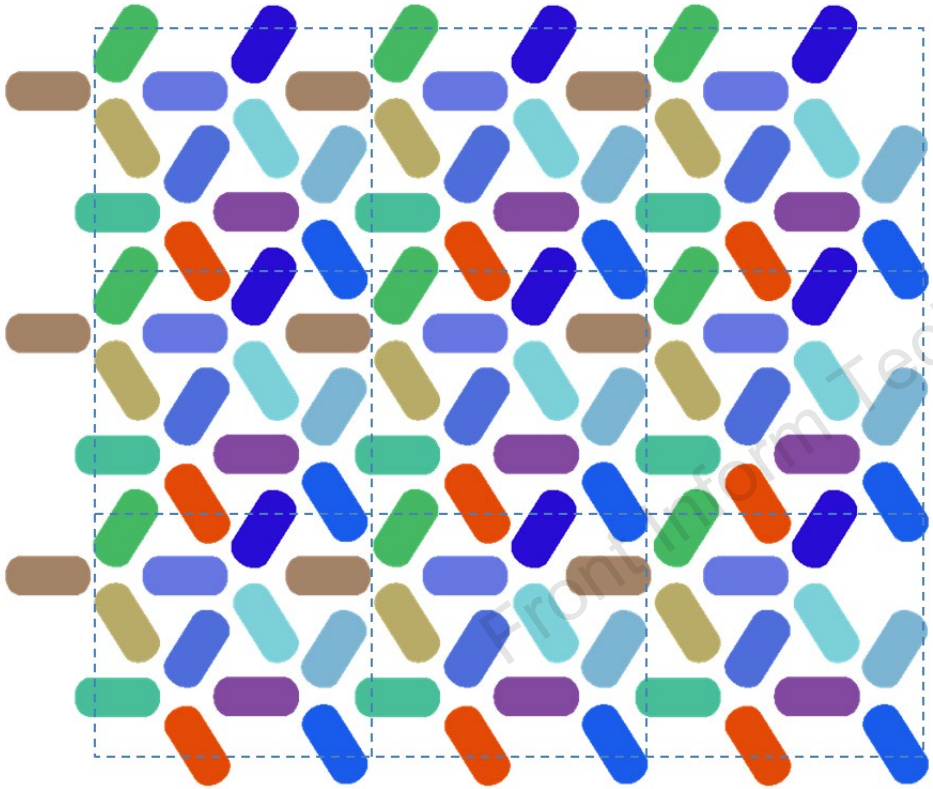
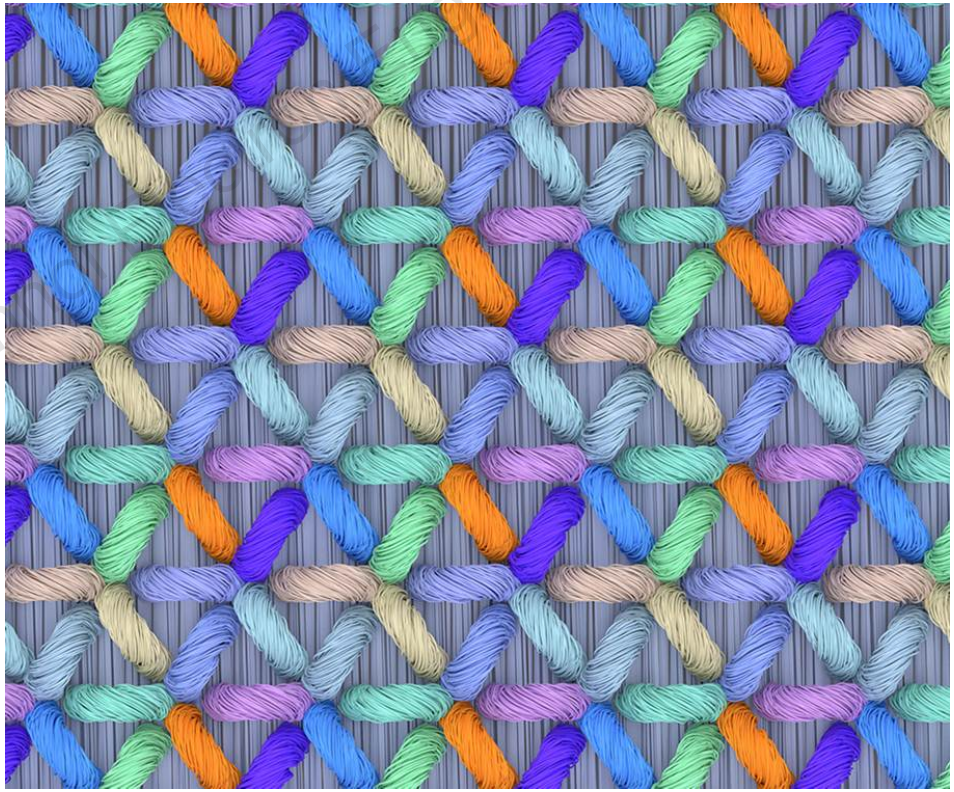
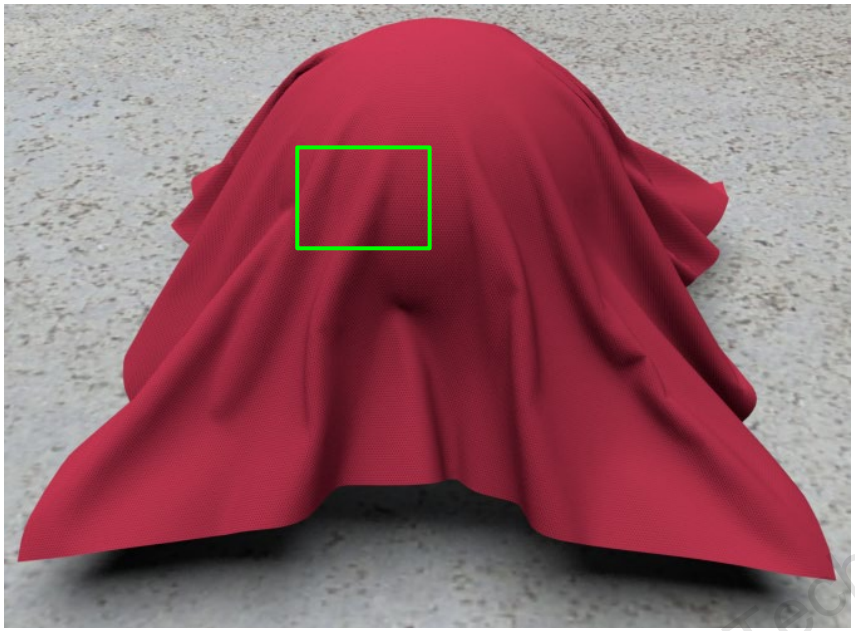
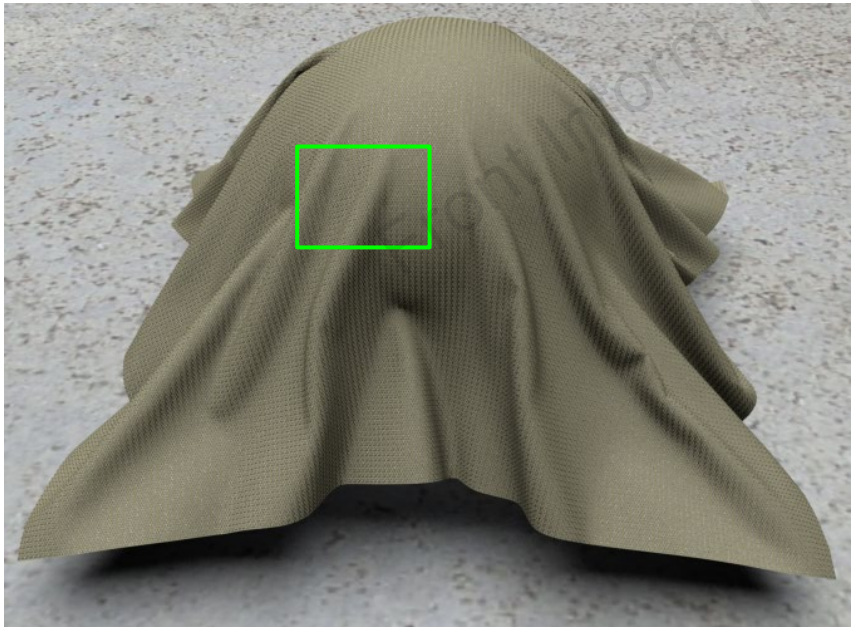


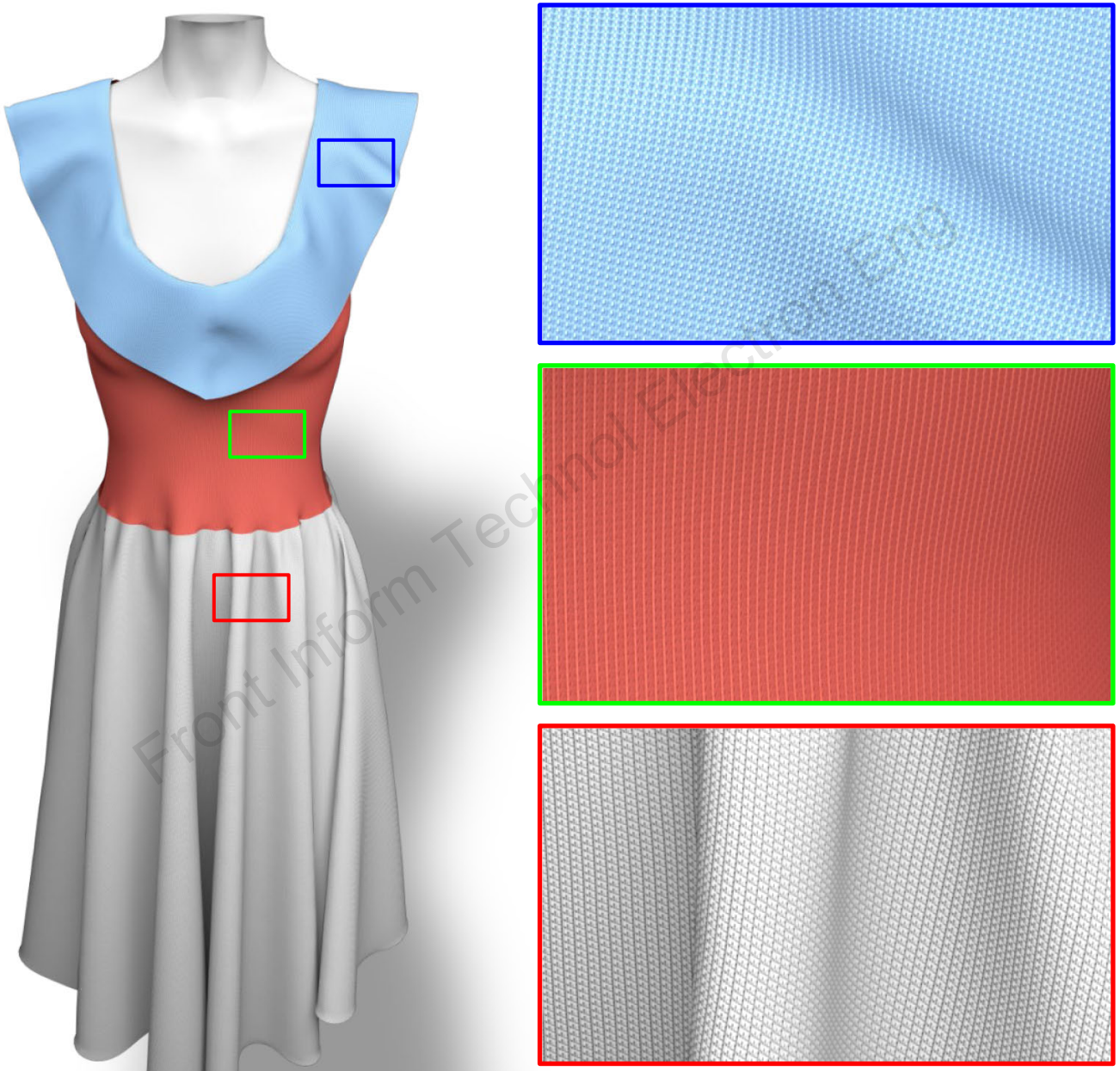


Results (Cont'd)



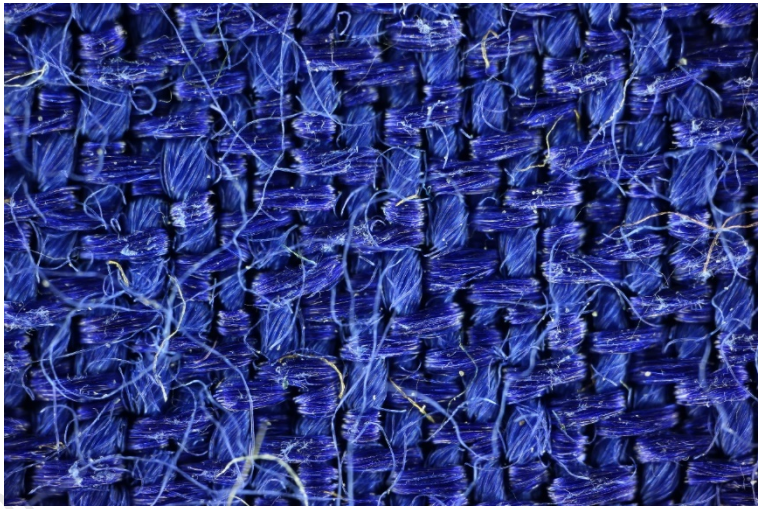


Results (Cont'd)

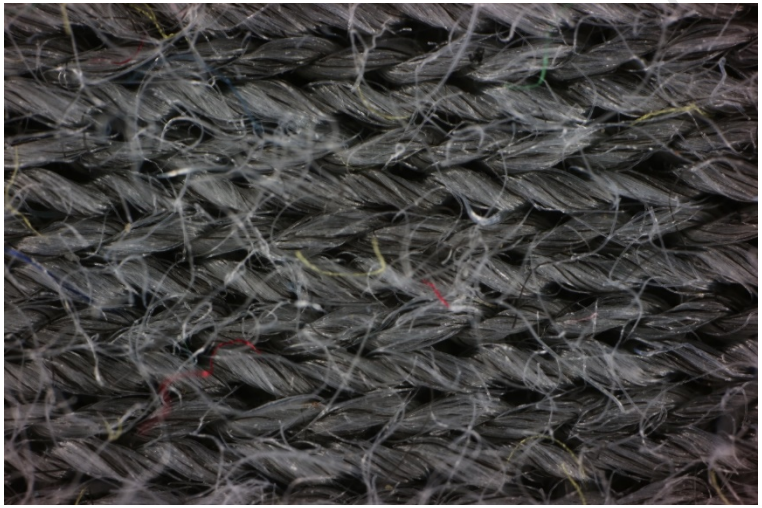


Limitations

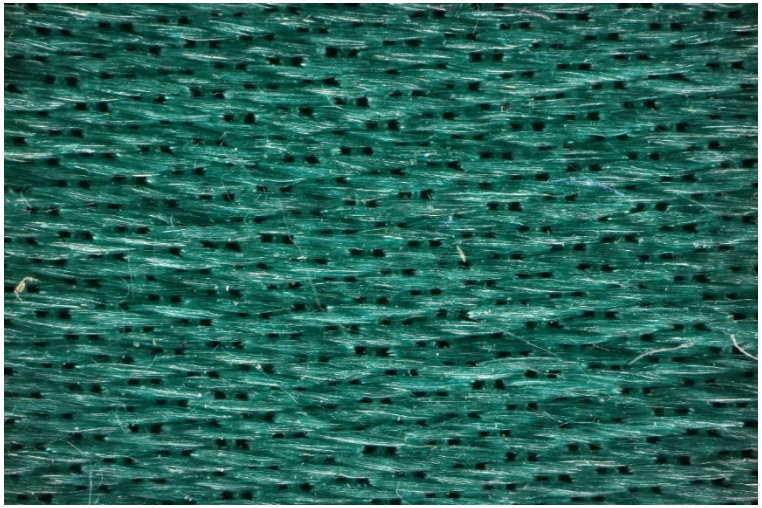
Non-woven cloth



Seriously distorted

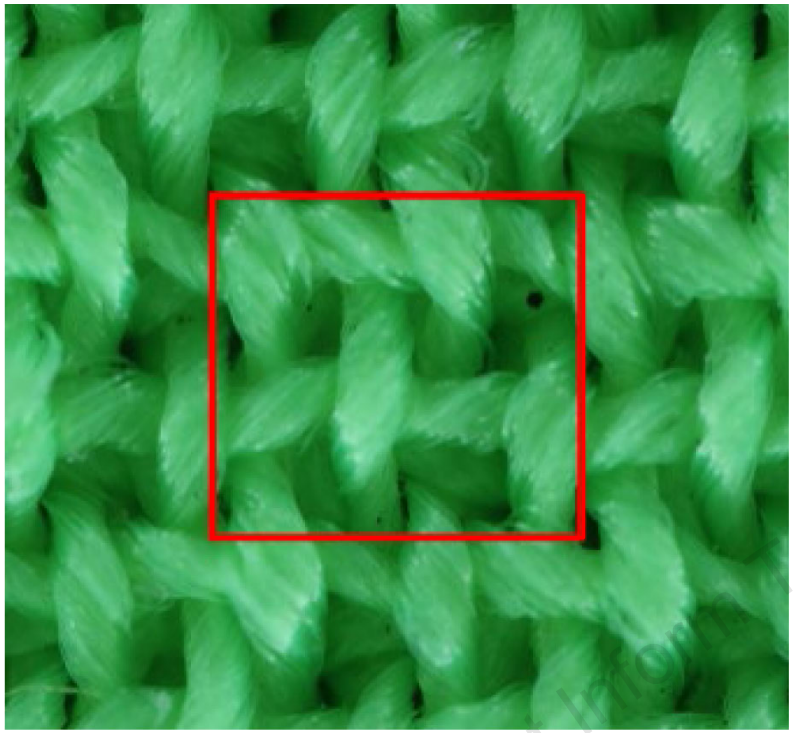


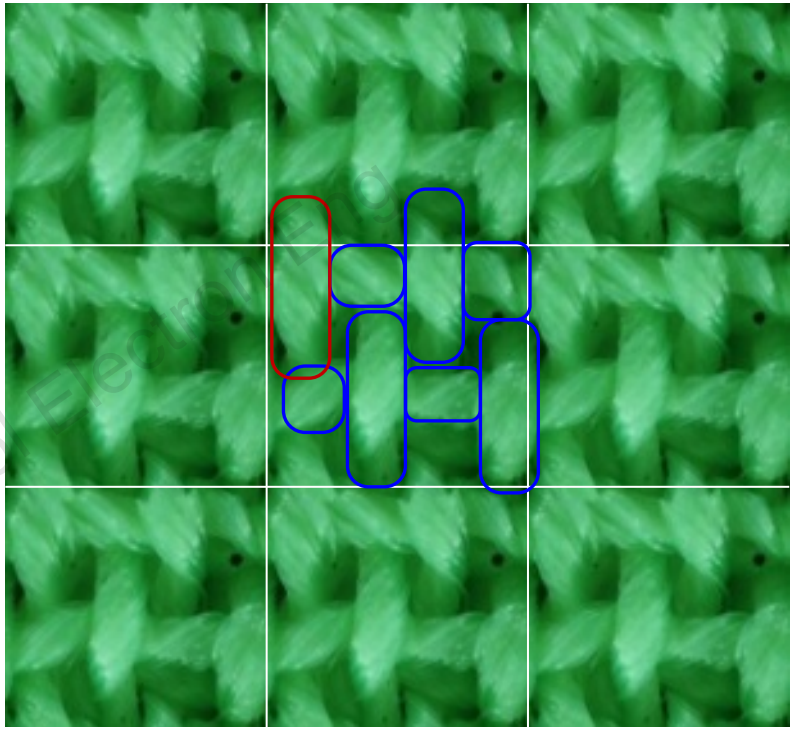
Heavy density of flyaway fibers



Transparency yarns

Limitations (Cont'd)





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