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YARN-LEVEL MODELING OF KNITTED FABRICS

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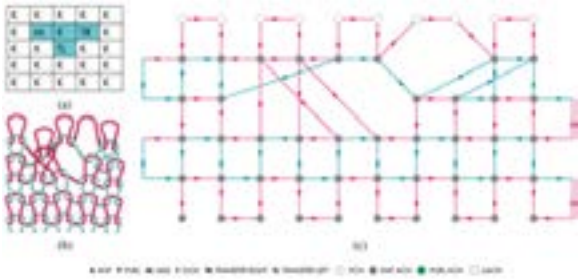

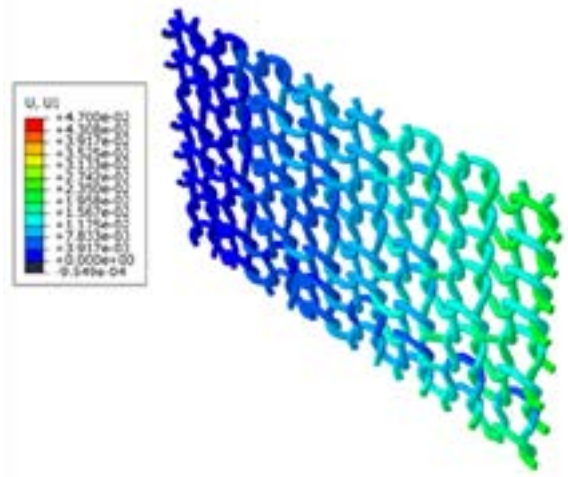

In an effort to develop computational models that can predict the properties and behaviours of weft-knitted fabrics, two low-level models have been developed that represent the topology and geometry of the yarns in these types of fabrics. TopoKnit is a system that is capable of generating a yarn topology graph directly from a stitch pattern of a weft-knitted fabric consisting of Knit, Purl, Transfer, Miss and Tuck stitches.[1] Via an application of an optimization process, solid geometric models of the yarns in a weft-knitted fabric may be generated. The resulting geometric models meet the strict contact constraints between adjacent yarns required by downstream Finite Element Modeling (FEM) simulations.[2]

Our topology work focuses on modelling knitted textiles within a process space. Process space models the abstract processes that lead to the formation of the material. In our work we focus on the processes that locally manipulate yarn loops at the stitch command level. The two critical components of the material that play a central role in this process are the yarn and the yarn intertwining where the yarns connect with each other.

Producing geometric models of yarns suitable for FEM is framed as an optimization problem. A "cost" function is specified in such a way that finding the variable values that produce a minimum function evaluation generates the desired geometric result. The features incorporated into our cost function include maintaining yarn rest length, minimizing curvature and creating contact points between crossing yarns. The variables that are modified to minimize the cost function are the spline control points that define the centerlines of the tubes used to represent the yarns.

Both models have been implemented and compared against other computational models and actual knitted fabrics to verify their accuracy. The yarn-level geometric models have been employed in FEM simulations that compute the out-of-plane motion and reaction forces resulting from in-plane strain. In current work, the yarn topology graphs are being used for both flow simulations and permeability analysis of knitted fabrics.

Keywords: *weft-knitted fabrics, yarn topology models, solid geometric models, FEM simulation, flow and permeability analysis.*

[1] L. Kapllani, et al., "TopoKnit : A Process-Oriented Representation for Modeling the Topology of Yarns in Weft-Knitted Textiles," Graphical Models, Vol. 118, Paper 101114, October 2021.

[2] P. Wadekar, et al., "An Optimized Yarn-level Geometric Model for Finite Element Analysis of Weft-knitted Fabrics," Computer Aided Geometric Design, Vol. 80, p. 101883, June 2020.