Representing Crochet with Stitch Meshes

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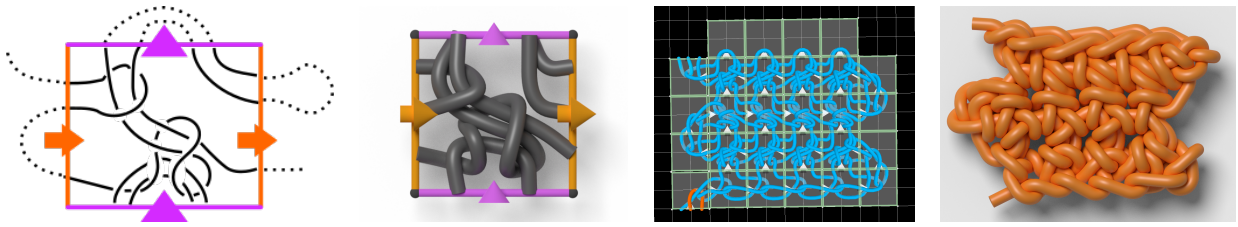


Figure 1: We have constructed stitch-mesh-like tiles for basic crochet stitches. These tiles can be used to build crochet patterns on 3D meshes for design, rendering and simulation.

ACM Reference Format:
Michelle Guo, Jenny Lin, Vidya Narayanan, and James McCann. 2020. Representing Crochet with Stitch Meshes. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Posters (SIGGRAPH '20 Posters), August 17, 2020.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3388770.3407448

1 INTRODUCTION

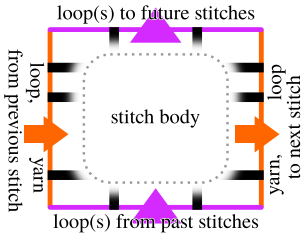
Crochet and knitting are two different techniques for textiles fabrication that involve flexible manipulation of a single continuous strand of yarn into interconnected loops that form a final stable object. It is natural, therefore, to ask if methods used to represent knit objects in computer graphics can be used to represent crochet as well. This poster answers in the affirmative, demonstrating that, with an appropriate new vocabulary of faces (tiles), the stitch meshes approach [Yuksel et al. 2012] can be extended to support crocheted objects (Figure 1).

Crochet and knitting differ in how loops are held and formed and in how the basic building blocks of patterns are described. In crochet, a single *crochet hook* is used both to hold a single *leading loop* and to pick up existing loops from elsewhere in the in-progress piece to form new stitches. Whereas in knitting, a queue of loops are held on knitting needles, and stitches are formed by operating (almost exclusively) on these active loops.

These differences in how loops are manipulated (particularly, the idea of a leading loop that is constantly used and re-formed) motivate our selection of edge types for representing crochet faces with stitch meshes. In order to select face contents, we draw on the Craft Yarn Council's standard list of crochet chart symbols [2018].

SIGGRAPH '20 Posters, August 17, 2020, Virtual Event, USA

ACM ISBN 978-1-4503-7973-1/20/08.
https://doi.org/10.1145/3388770.3407448



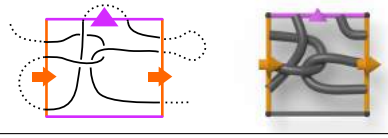
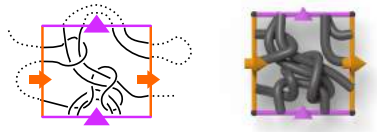
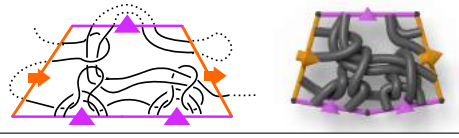
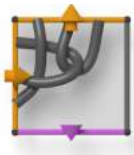
2 APPROACH

Stitch meshes represent yarn paths as a mesh of connected faces, each of which contain yarns. Edges are labeled based on the yarns that cross the edge in order to ensure yarn continuity. In order to construct a set of crochet tiles for use in the stitch mesh framework, we first needed to determine suitable edge types for use in crochet.

In crochet, a stitch always starts with the free end of the yarn held in one hand and the leading loop (the most recently formed loop from the last stitch) held on the crochet hook. Loops are worked through previously created stitches to create a new stitch; which may, in turn, be used to anchor loops in future stitches. When the stitch is finished, a new leading loop is held on the crochet hook, and the free end is still in the crocheter's hand. These actions establish two types of dependencies between stitches: short-term (previous-next) dependencies based on the free end of the yarn and the leading loop, and long-term (past-future) dependencies based on working loops through existing stitches.

Thus, we define the edge types as *previous* edges which connect to *next* edges and are crossed by a free yarn and a single loop, and *past* edges which connect to *future* edges, over which a stack of loops pass. Note that we follow the directed-edge-types convention

Table 1: The set of crochet stitch mesh faces we have created so far. Not shown, though present in our tileset, are mirrored (left-right and in-out) versions of the tiles and tiles that connect to a single loop instead of a stack of two loops.

Standard Faces:		
Chain Stitch (ch) – used in starting row.		
		
Single Crochet (sc) – basic building block.		
		
Single Crochet Two Together (sc2tog) – narrows fabric.		
		
Utility faces:		
Turn (ch_edge{1,2}) turns yarn at row ends.	Cap (cap) connects stitch back to itself.	Increase (inc) widens fabric.
		

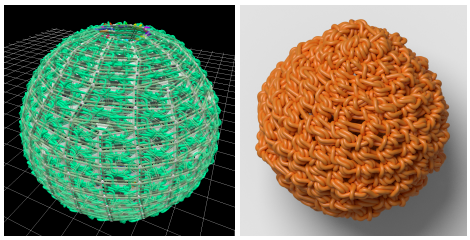


Figure 2: Left: crochet stitch mesh of a sphere; right: after yarn-level relaxation.

of Narayanan, et al. [2019], which is natural fit for stitch meshes modeling real-world fabrication processes.

With these edge types defined, we can now build a set of tiles. We chose to work from the Craft Yarn Council's standard list of crochet chart symbols [2018]. For each stitch type, we built a stitch mesh face by referring to construction instructions [Barnden 2013; Omdahl 2019; Schäpper 2012], drawing a knot diagram, and then translating this diagram into the finished yarn path. We also created a few utility faces to deal with situations implied by crochet instructions but not made explicit in charts. All of the faces we created are described in more detail in Table 1.

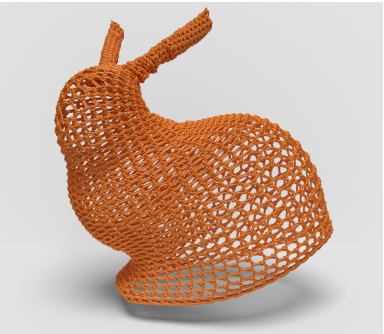


Figure 3: Complex 3D surfaces like the Stanford bunny can be turned into a crochet pattern using our crochet tile-set.

3 RESULTS AND FUTURE WORK

In order to test our stitch mesh faces, we created several objects using a stitch mesh editing interface that allows us to load an .obj file and assign face types. Our simplest example is a single-crocheted rectangle (Figure 1). This rectangle uses the ch, sc, ch_edge1, ch_edge2, and cap tiles. Placing the yarn path for this rectangle into a basic simulator caused it to tighten and not unravel. By adding the inc and sc2tog tiles, we can make patterns that cover a sphere (Figure 2) and Stanford Bunny (Figure 3) with faces. In both cases, the initial mesh is created using the approach of Narayanan et al. [2019]; modified to avoid short-rows. When simulated, the sphere takes on a crochet-like appearance.

While the vocabulary of stitches we have defined so far is sufficient for modelling many crocheted structures, it is not complete. First, we have only constructed faces for the more common standard stitches (though there is no technical barrier to creating more). Furthermore, in crochet, one can always select which portion of the existing cloth to work a loop through. In our framework, this is modelled by selecting what yarns cross the *future* boundary of the stitch. When creating the 3D yarn path versions of the tiles, we routed the paths such that new loops pull through the internal structure of a stitch when possible, and through the center of a loop otherwise; this is common practice in crochet. In some cases, however, other variations of a stitch may be used for artistic or practical effect. Capturing all of these (potentially infinite) variations leads to additional modelling burden. In the future, a semi-automatic stitch face modelling framework might allow faces to be described to our system using atomic construction operations, with yarn paths automatically determined.

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