TEXELS: A Programmable Textile Interface for Replicating Textures

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TECHNICAL BACKGROUND

Active textiles and **Programmable textiles** have been developed to respond to external stimuli by changing shape. However, current implementations suffer certain limitations to usability and potential applications

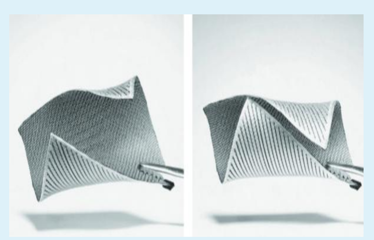
Limitations to Usability

1. Requiring bulky accessories to operate
2. Requiring unintuitive software applications
3. Having to be fabricated by the user rather being readily available

4D Knit Dress – MIT Self Assembly Lab
Limitations 1, 6

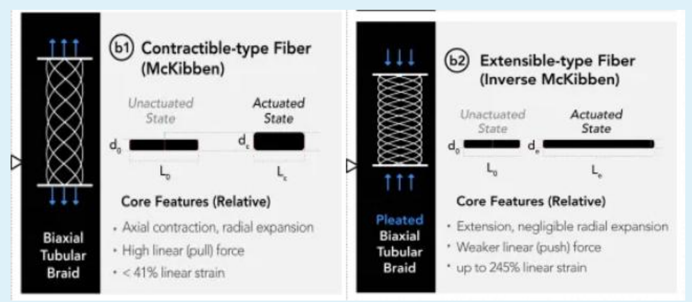
Limitations to Achievable Shapes

4. Only approximating shapes with repeated polygons
5. Capable of only one "activated" shape
6. Range of movement limited to only expanding and contracting



Programmable Textile – Active Matter by Skylar Tibbits
Limitations 3, 5

NURBSforms – MIT CSAIL Limitations 2, 3, 4

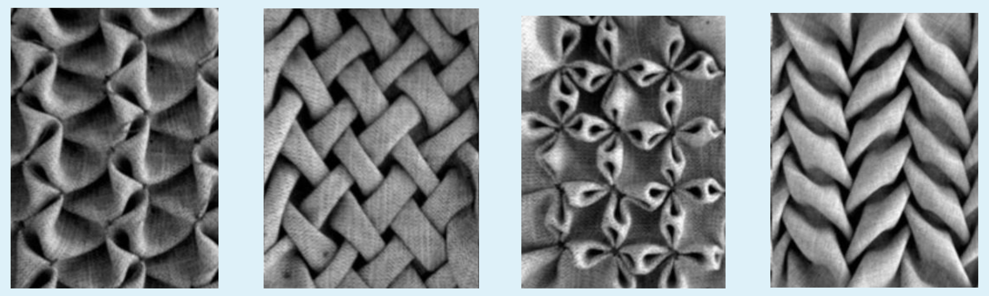


OmniFiber – MIT Tangible Media, KTH Royal Institute of Technology, and Uppsala University
Limitations 1, 6

TECHNICAL MOTIVATION

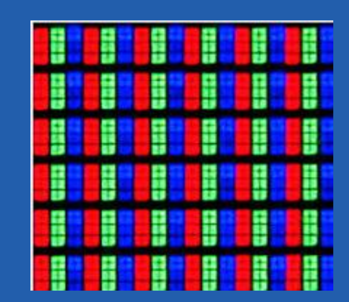
This thesis aims to create a novel **textile interface** that…

- Is self-actuating
- Can replicate any given texture from a height map
- Is reusable and reprogrammable
- Is compatible with traditional textile machinery and techniques



Illustrative – Contemporary smocking techniques from thecuttingclass.com

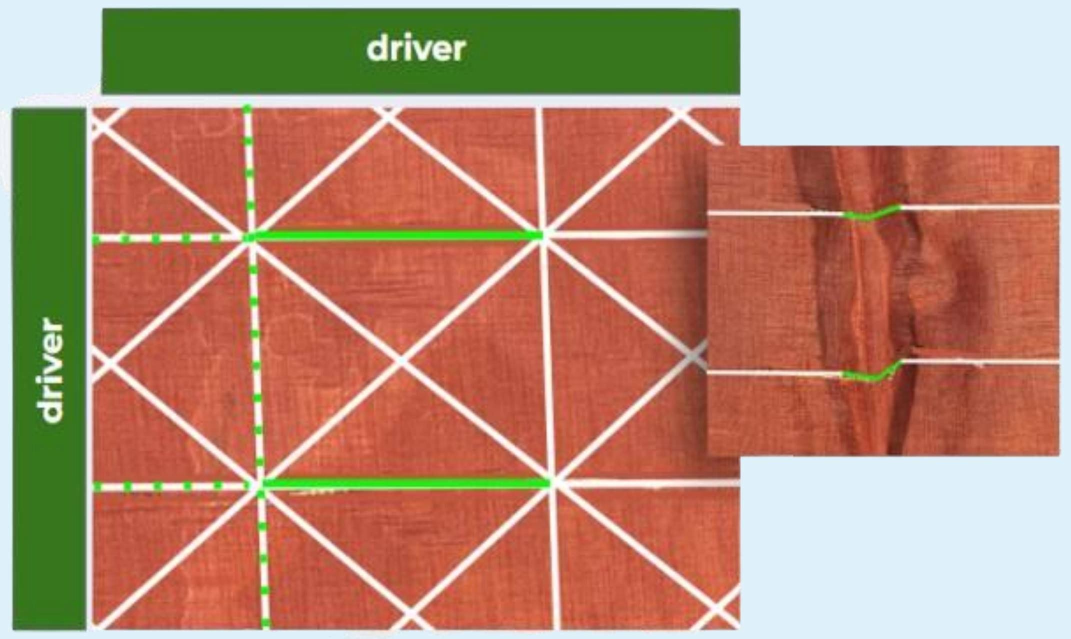
THEORY

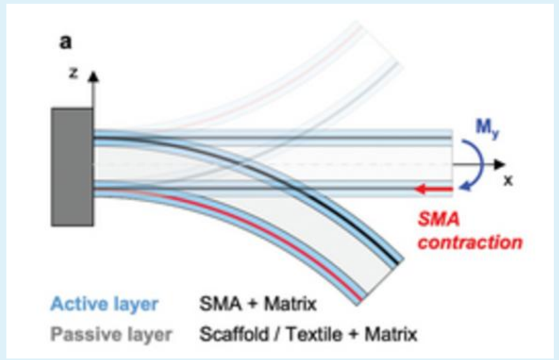


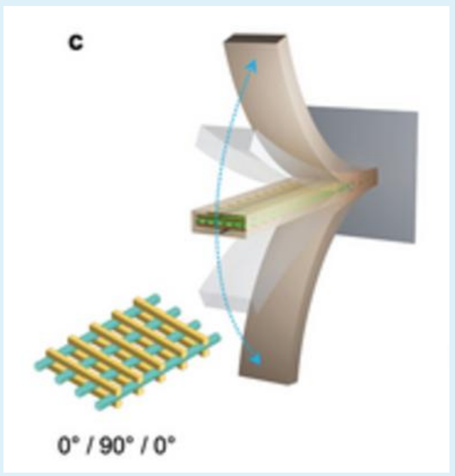
PIXELS

Inspired by how pixels are assigned color data, Texels will be a physical **array layout** of **individually addressable units**. Each texel will be given a **shape value** instead of a color, in accordance with a desired texture map passed through the software.

TEXTILE







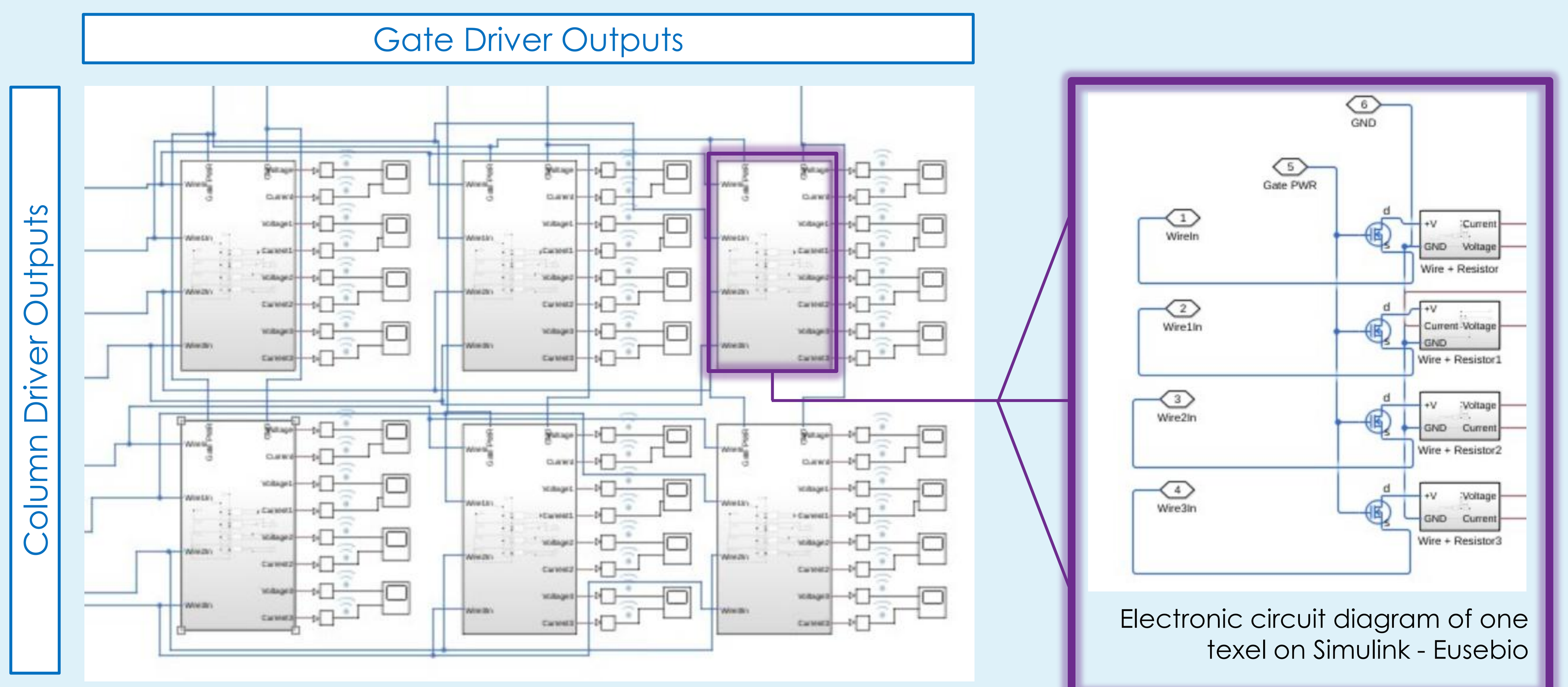
M. Kim et al., "Shape Memory Alloy (SMA) Actuators: The Role of Material, Form, and Scaling Effects," Advanced Materials, Apr. 2023

Each texel will consist of four embedded **shape memory alloy wires**. Sending a specific voltage to these wires via electrical impulses will cause the wire to **change shape** and thus pull the fabric into its assigned shape.

PROTOTYPING

We defined an **electrical circuit** that can stimulate **each texel** in the fabric with a voltage.

The **Gate Driver** activates one row of texels at a time, while the **Column Driver** sends voltages to the wires that must be activated in that row, like in an **LCD display**.



Electronic circuit diagram of an array of six texels on Simulink - Eusebio

Electronic circuit diagram of one texel on Simulink - Eusebio

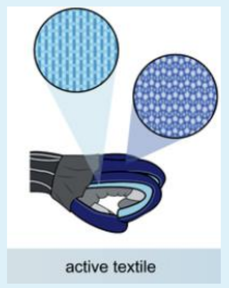
After assembling the **physical hardware**, we will implement a **software interface** that programs the drivers to activate the correct pixels following user input of a **Canadian smocking pattern**.

FURTHER WORK

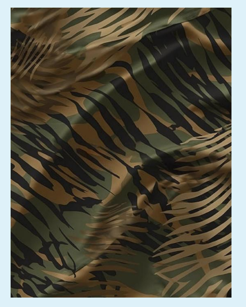
Several **demos** will be created with faculty from different departments and institutions to illustrate the fabric's potential uses in various fields.

Providing haptic feedback and sensory communication aids

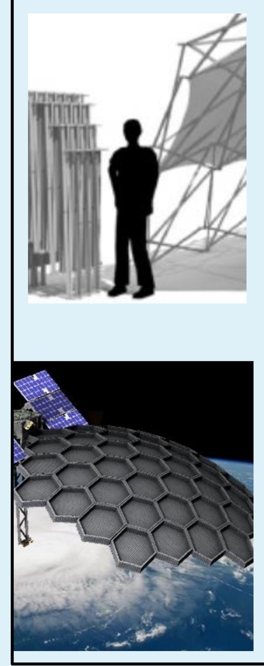
Simulating textured surfaces in virtual reality



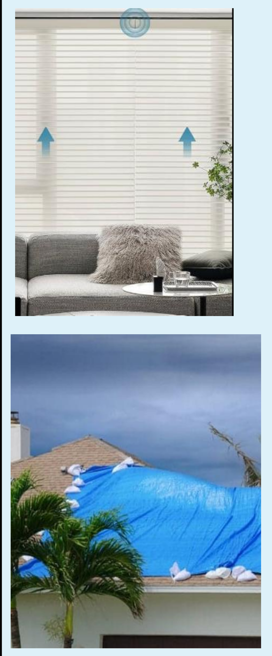
Therapeutic wearables and furniture for aging care



Real-time adaptive camouflage



Producing compact, self-assembling structures for space exploration or disaster response



Weather-resilient building infrastructure like smart curtains or tarps

IN THE FLORIDIAN CONTEXT

Active textiles represent a promising frontier for **Infrastructure Technologies** that could address **Florida's most pressing issues**. Our large **elderly population** could benefit from comfortable assistive technologies, and the **themed entertainment industry** could create interactive environments and costumes. Building coverings that respond to their environment would reduce the **energy cost** of cooling systems and prevent **weather damage**. This is directly relevant to the **insurability of future homes** and provides a simpler tool for bringing older buildings up to current resilience standards. Finally, these textiles could be compact, reusable structures that self-assemble for **disaster relief** or space **deployment**.

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