**Turing Patterns based Design and Fabrication of Inflatable Shape Morphing Structures**

**Abstract**: *A Bio-inspired 4D printing system of shape-morphing inflatable structures is demonstrated by printing distribution of material orientations of their surface membrane. Material orientation field is obtained using gradient-based optimization algorithm that continuously modifies preferred direction at each material point to improve design objectives. By prescribing orientations, we can program local deformation of material and thus control their global shapes. The membranes are fabricated with robust mechanical properties by grayscale digital light processing (g-DLP) 3D printing. Each pixel in this printing system, however, is limited to isotropic material. Therefore, our approach converts the anisotropic material field into discretized Turing pattern texture that induces anisotropic deformation of the surface membrane, in which every pixel is classified as stiff or soft material. Complex shapes of the Turing pattern texture can be fabricated with our g-DLP 3D printing system which can broadly tailor materials of modulus up to three orders of magnitude within a layer. Furthermore, we address fabric-based manufacturing method by designing and tuning the geometric pattern of reinforcement sheet embedded into an unstructured elastomeric membrane. The present methods provide one of solutions for 3D printing of anisotropic inflatable membrane structure that directly produces the fabrication instruction. These techniques are expected to have an impact on the design and fabrication of the shape-morphing inflatable structures.*

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