Bio-Inspired Multi-Modal Pneu-Nets
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Pneumatic networks (pneu-nets) are soft actuators driven by air pressure input. These actuators are generally used for crawling locomotion or grippers and can even be designed to deform into more complicated structures through the use of multiple air inlets. Here, we develop a pneumatic system capable of complicated differential morphing using the inherent property of strain hardening of hyperelastic elastomers using only a single input. This eliminates the need of a complex manufacturing process and can be adapted to existing pneu-net manufacturing processes when designed appropriately to increase the mode of deformation.

The lotus leaf in nature shows differential growth [1] at the point of bifurcation and changes curvature. Inspired by this unique characteristic, a radially spaced pneumatic channel is designed with increased surface area at the bifurcation points. Sequential activation of the bifurcation points at a low pressure $P_1$ and straight channel regions at a higher pressure $P_2$ show multi-modal pneu-nets using only a single input. This is not only limited to change in curvature of bending, but can be extended to sequential bending, stretching and twisting to perform tasks such as self-standing crawling soft robot, or grabbing and turning on a light bulb by merely increasing the pressure.

Fig. 1: Bird’s eye view (A), and side view (B) of a lotus leaf-inspired pneu-net

References