<Supplemental figures>

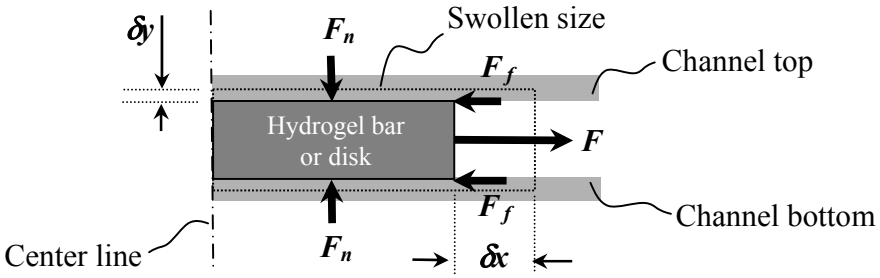
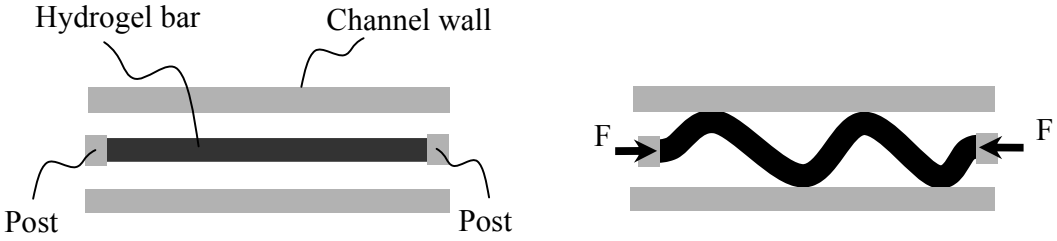


Figure S1 Force diagram of a cross-sectioned hydrogel bar or disk. The normal reacting force (F_n) onto the hydrogel bar or disk induced by swelling is proportional to the amount of constricted perpendicular swelling (δy) according to Hooke's law when the swollen hydrogel is assumed to be a Hookean material and to have negligible weight. F and F_f indicate the longitudinal swelling force and frictional force, respectively.



(a) Top view of a hydrogel bar before buckling

(b) Top view of a hydrogel bar after buckling

Figure S2 Schematic illustration of a hydrogel bar undergoing buckling. The reacting force (F) at the end of hydrogel bar - induced by swelling of the hydrogel - causes buckling since the hydrogel bar acts like an elastic beam under axial compression.

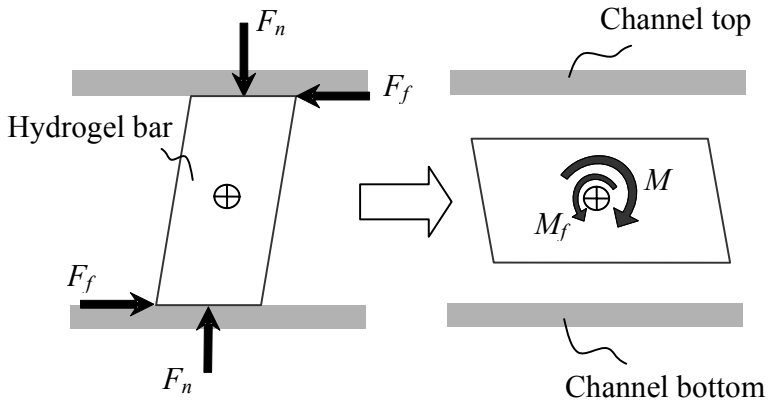
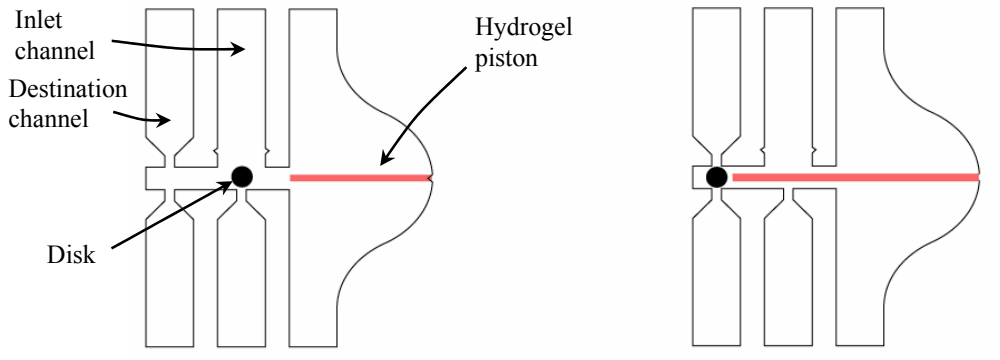
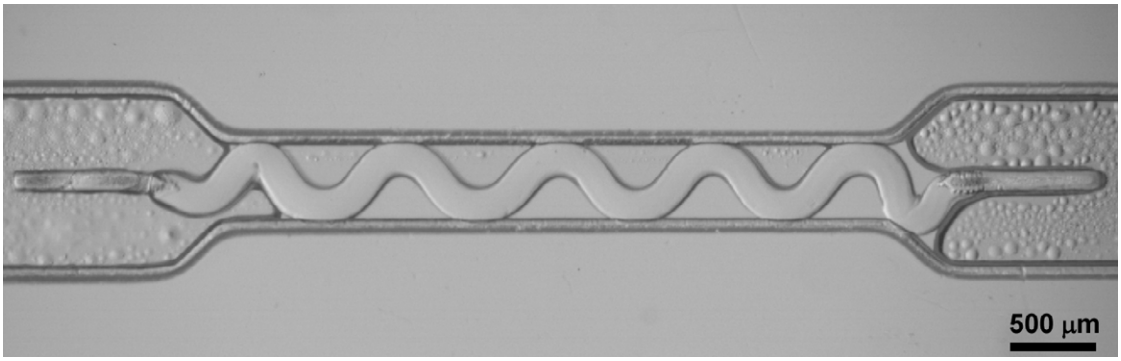


Figure S3 A free body diagram of the cross-section of the hydrogel bar. As the hydrogel bar swells, the off-centered reacting forces (F_n) apply onto the top and bottom of the hydrogel bar and eventually the hydrogel bar flips over as the moment (M) of the hydrogel bar, induced by F_n, becomes large enough to overcome the negative moment (M_f) caused by the frictional force (F_f). Because of this, it is possible to control the direction of flipping and ultimately avoid the irregular flipping and buckling.

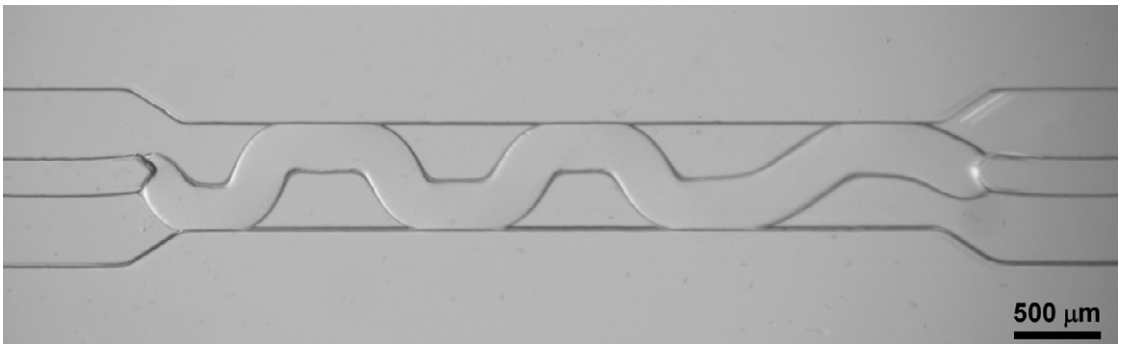


a) Before delivery b) After delivery

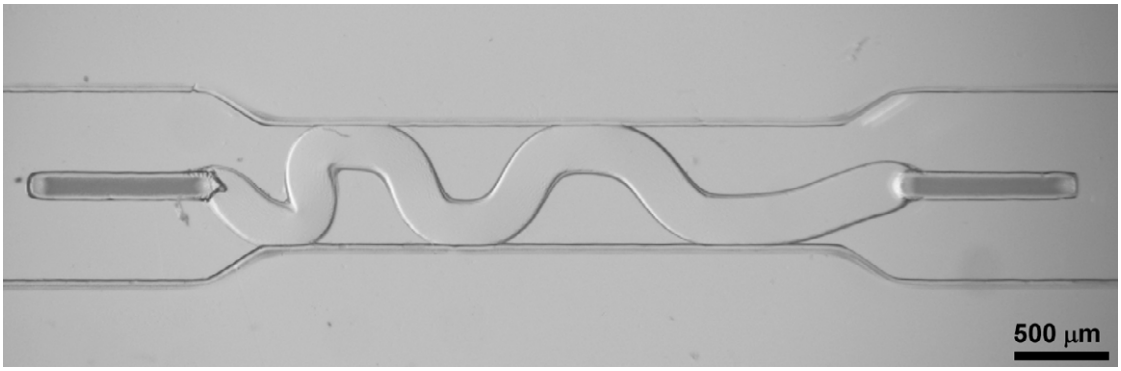
Figure S4 Conceptual diagram of the delivery piston. After inserting the disk through the inlet channel, the hydrogel piston is triggered to push the disk to the designated position.



(a) Buckling of 4.8 mm long hydrogel bar

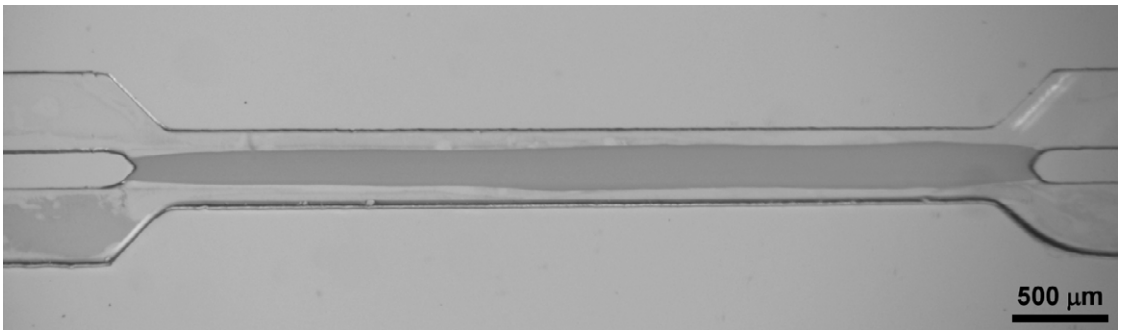


(b) Buckling of 3.8 mm long hydrogel bar

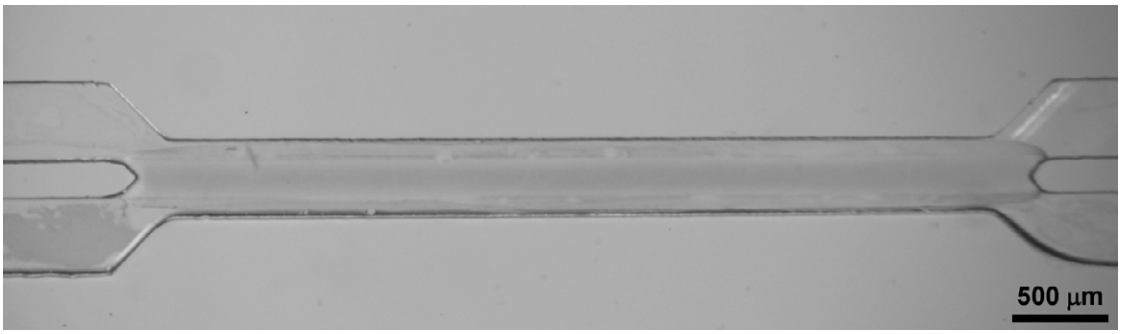


(c) Buckling of 2.8 mm long hydrogel bar

Figure S5 Buckling of hydrogel bars polymerized to have a different length. The time before the buckling started to close the active walls took 4 min, 10 min, and 20 min for 4.8, 3.8, and 2.8 mm hydrogel bars, respectively.



(a) Contracted state of temperature sensitive hydrogel at 50°C



(b) Swollen state of temperature sensitive hydrogel below 20°C

Figure S6 Image of an active wall using a temperature-sensitive hydrogel. The temperature-sensitive hydrogel tended to swell without buckling.

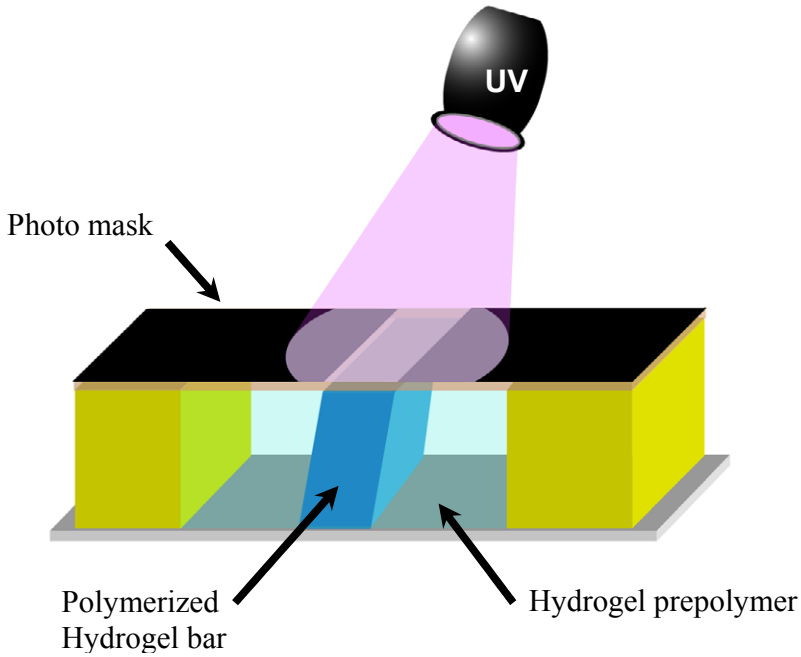


Figure S7 Cross-sectional view of flipping. Once the channel was fabricated, the hydrogel pre-polymer filled the channel and the hydrogel bar was polymerized in a slanted shape due to slanting of UV light with respect to position of the device.