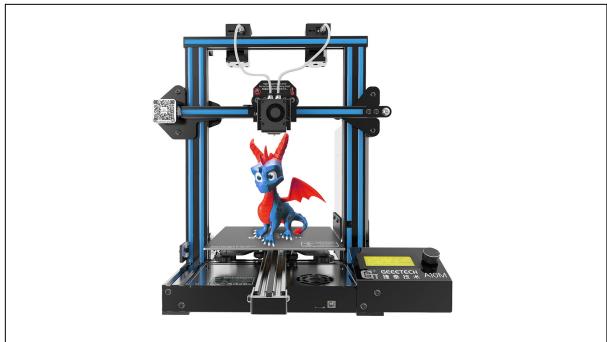


The first 3D printer: The SLA-1 from 3D Systems







Passive
Can't be interacted with



From static to interactive

Assembly

Calibration

Use limitations

Assembly

Calibration

Use limitations

AssemblyLe et al.
TEI '17**Calibration**Savage et al.
UIST '13**Use limitations**Hook et al.
CHI EA '14**Assembly****Calibration****Use limitations**

Assembly

Savage et al.
CHI '15

Calibration

Laput et al.
CHI '16

Use limitations

Schmitz et al.
CHI '19

Assembly

Calibration

Use limitations

Assembly



Hudin et al.
CHI EA '15

Calibration

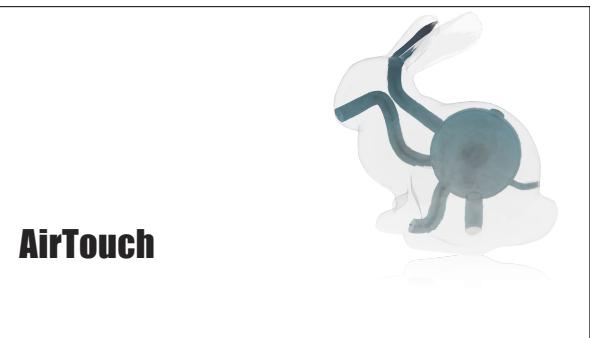


Tejada et al.
GI '18

Use limitations



Shi et al.
CHI '16



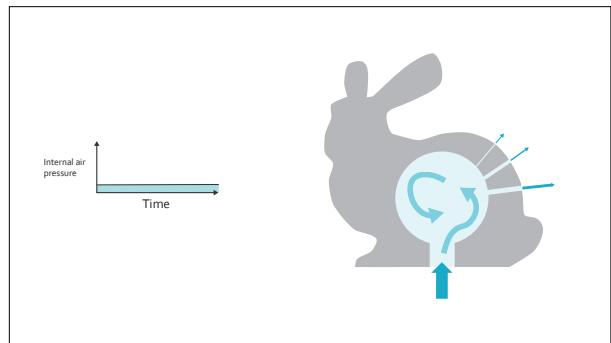
AirTouch

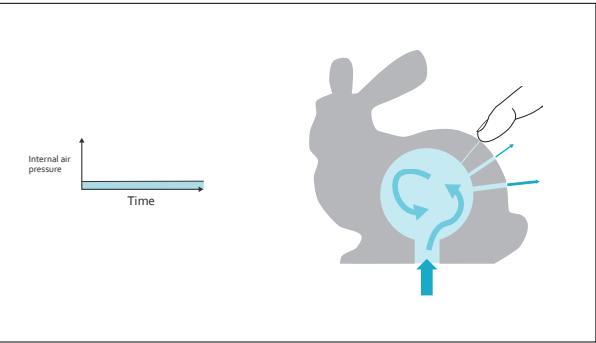
AirTouch

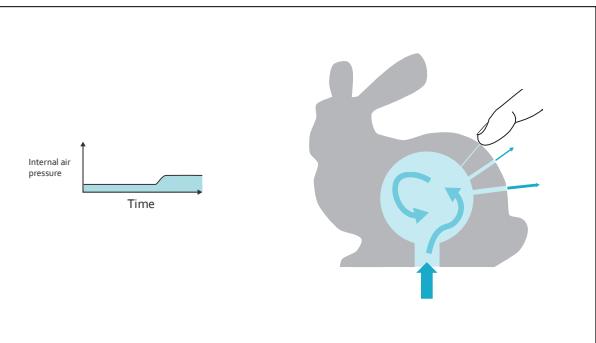
- No assembly of parts or circuits.
- No calibration.
- Single material, consumer-level 3D-printers.
- Minimal disruption of original geometry.

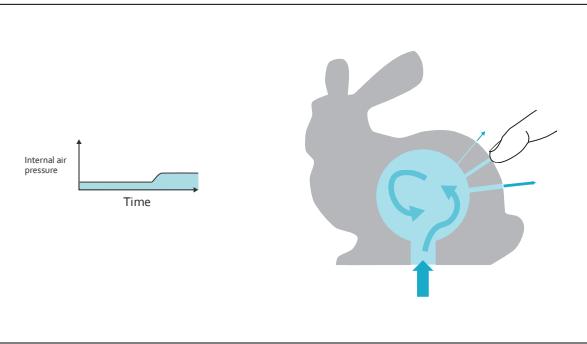


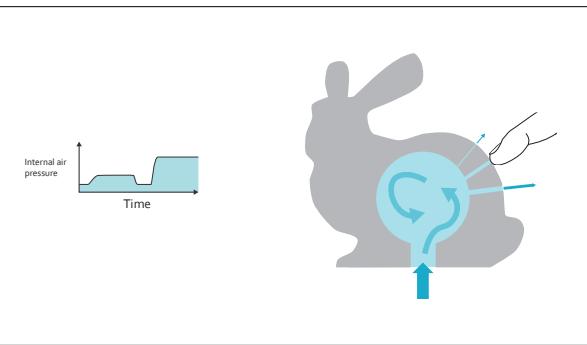
How does it work?











How does it work?

- Principle of fluid continuity.
- Bernoulli's principle.

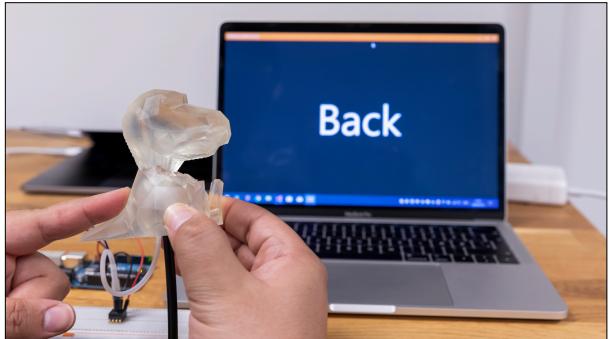
$$\Delta P_s = \frac{(\sum A_i)^2 \Delta P}{(\sum A_i - A_s)^2}$$

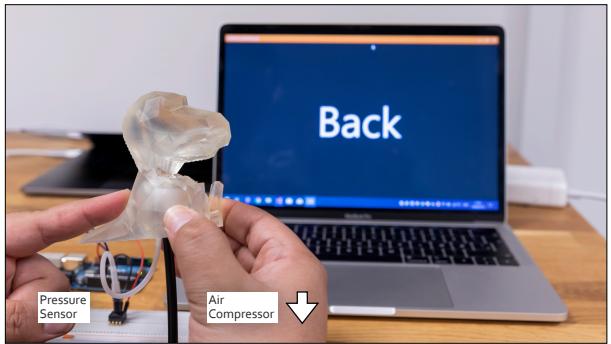
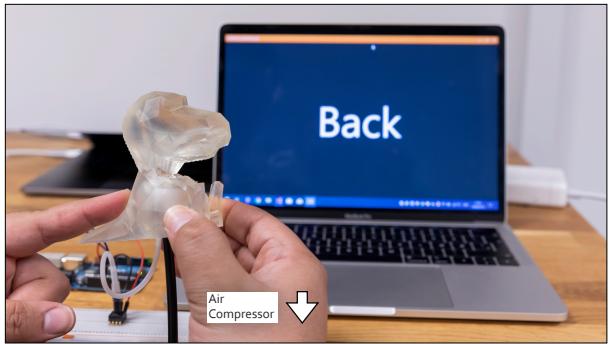
- Change in size of openings → Change in pressure.

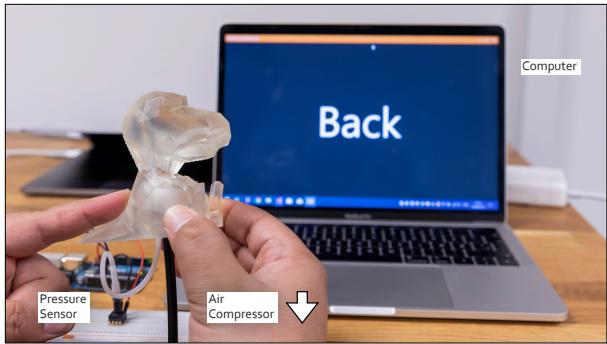
How does it work?

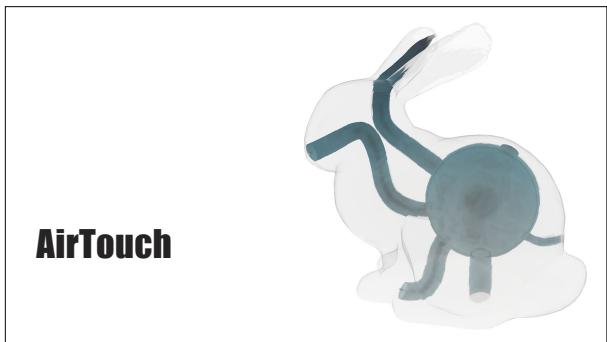
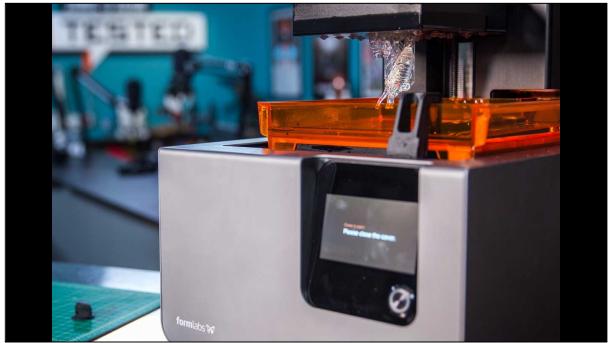
- Assumptions:
 - Incompressible fluids.
 - Perfectly shaped outlets and structures.
- Reality:
 - Air is compressible.
 - 3D-printed objects are not perfect.
 - Complex internal geometries.

Setup









AirTouch

- Cavity
- Tubes
- Outlets



Cavity

- Spherical cavities.
- 30 mm in diameter.
- Shared cavity size between all objects.
 - Shared machine learning model.



Tubes

- Cylindrical tubes.
- 5mm in diameter.
- Compromise between printability and size.

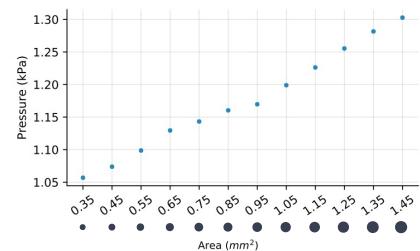
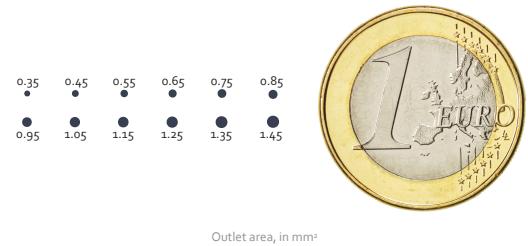


Outlets

- Outlets are placed on touch locations.
- Very small.
- Pressure increase depends on the area of outlet.



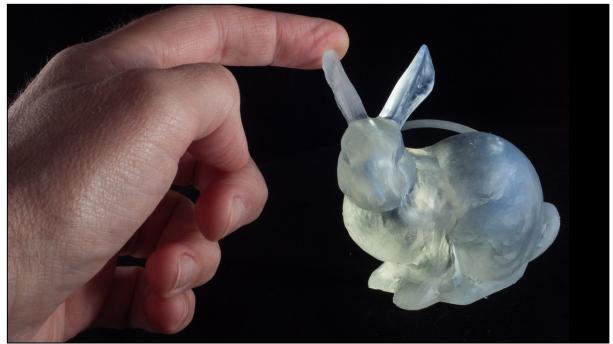
Final outlet dimensions

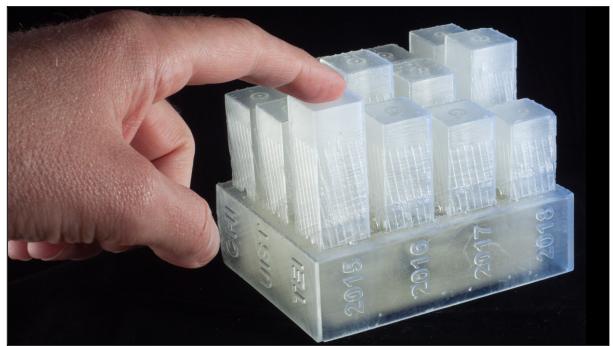


Performance Testing

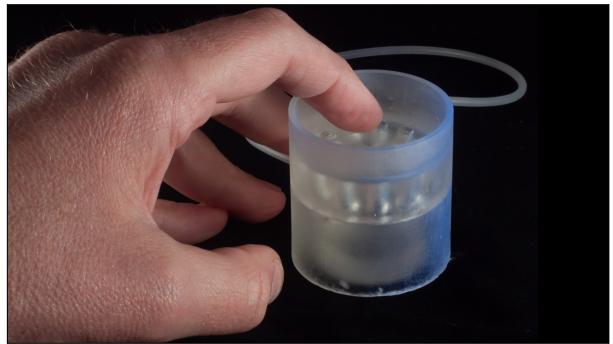
Performance Testing

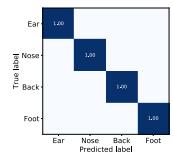
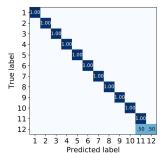
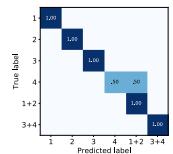
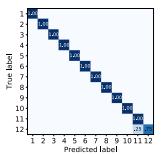
- Printed four objects.
- Pre-trained a machine learning model.
 - One instance per touch.
- Cycled through all touch locations.
- Repeated four times per object.







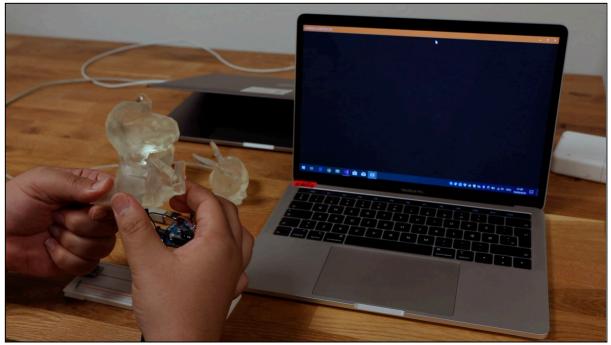


Stanford Bunny**100%****Interactive Bar Chart****95.50%****Grasping Sphere****91.60%****Color Hue Selector****97.75%**

Example Applications







Limitations

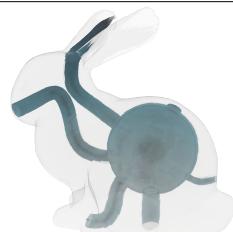


Atmospheric Pressure Changes

Takeaways

Takeaways

- No assembly of parts or circuits
- No calibration
- Single material, consumer-level 3D-Printers
- Minimal disruption of original geometry



AirTouch

3D-printed Touch-Sensitive Objects Using Pneumatic Sensing

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Looking for Postdoc positions, early 2021!
