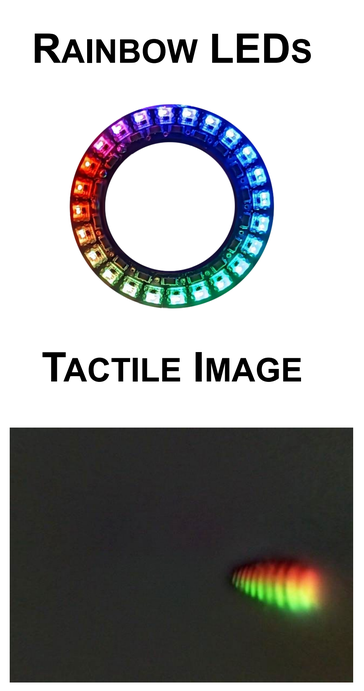
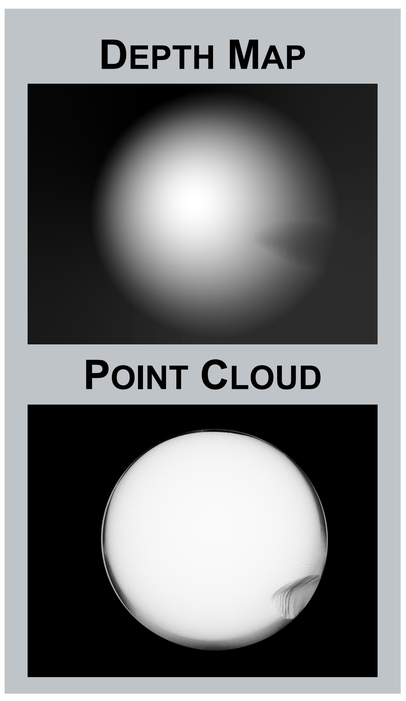
RainbowSight: A Family of Generalizable, Curved, Camera-Based Tactile Sensors for Shape Reconstruction

Megha H. Tippur and Edward H. Adelson
mhtippur@mit.edu, adelson@csail.mit.edu
Massachusetts Institute of Technology

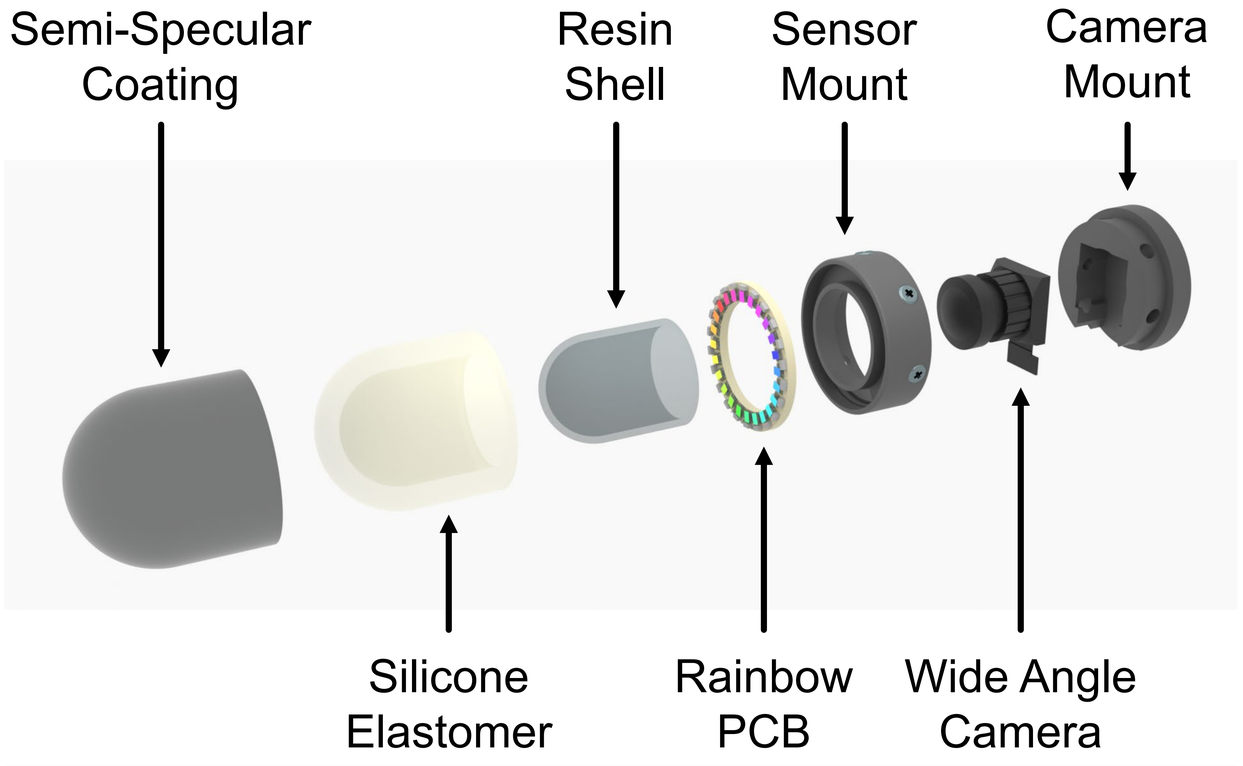
Main Contributions

1. **Novel rainbow illumination** scheme using a semi-specular coating that produces a blended color gradient.
2. **Sensor shape and size customization**.
3. **Simplified fabrication procedure** compared to our past sensor (GelSight360) without any surface occlusions.
4. **Improved depth reconstructions** of the contact deformations occurring on the surface of the sensor.

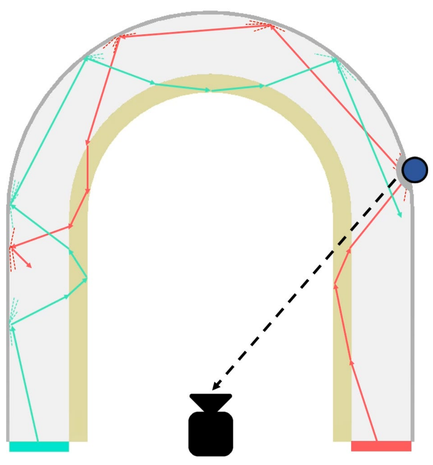




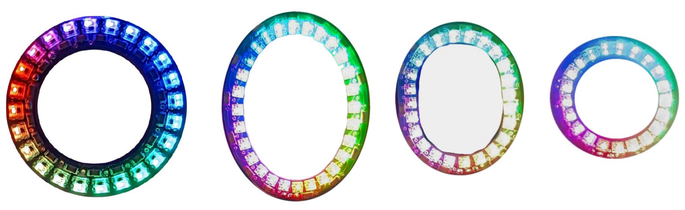
Design and Illumination Approach



Sensor Side View



Rainbow LED PBCs mimic a **continuous color gradient** with discrete RGB LEDs.

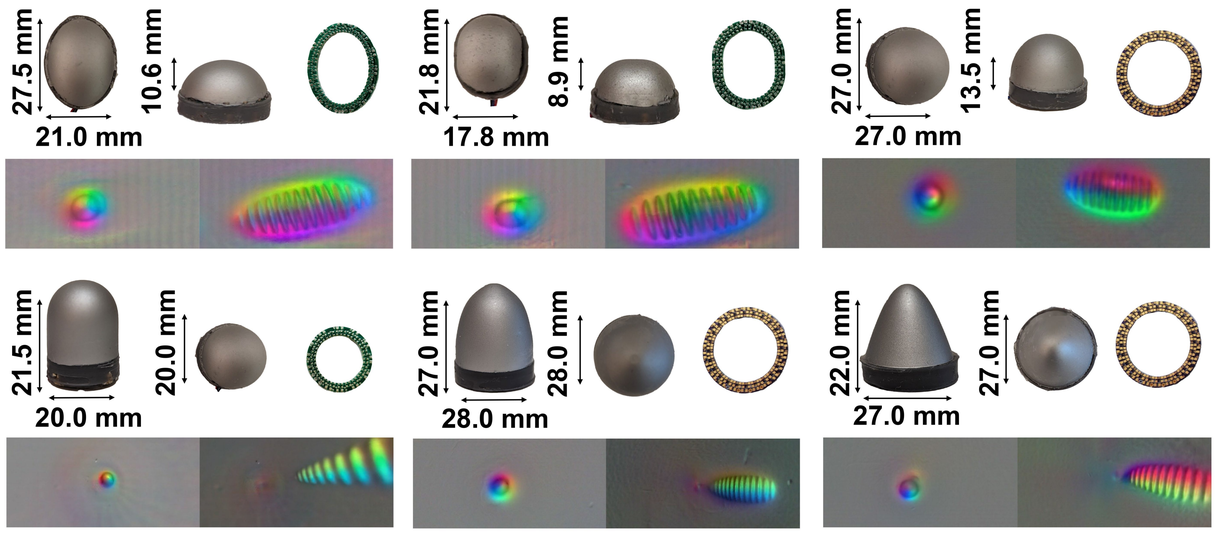


Between **21 – 28 LEDs** are placed on each ring. Each LED is assigned a specific **Hue, Value,** and **Saturation**.

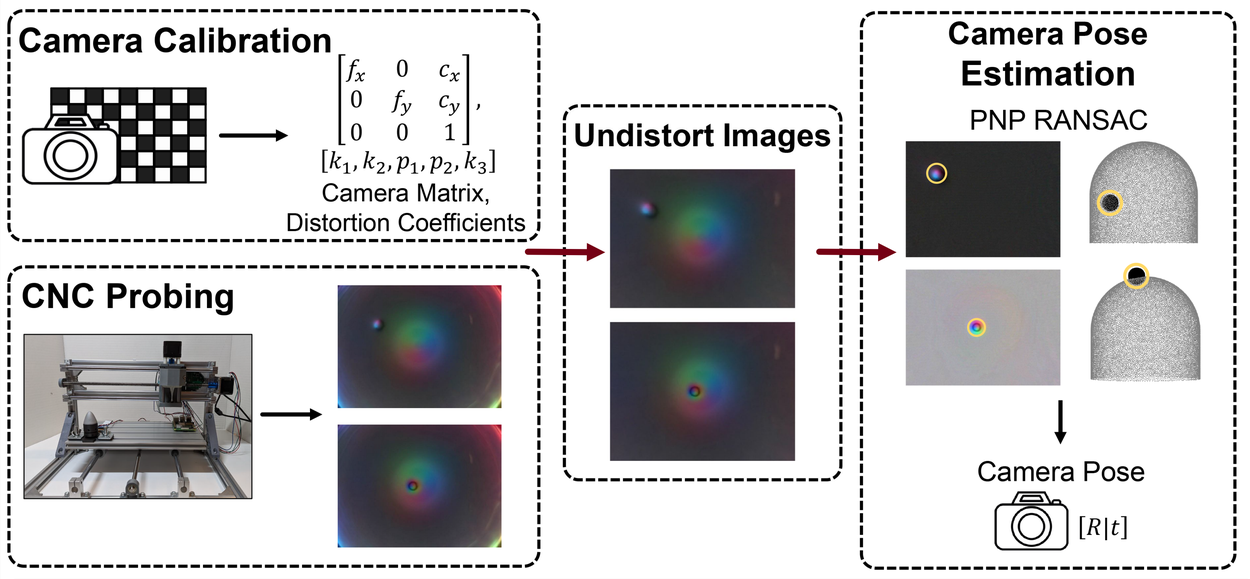
Sensor can be shrunk down to **~20mm**, similar to the size of a **human index finger**.

Alternate Sensor Geometries

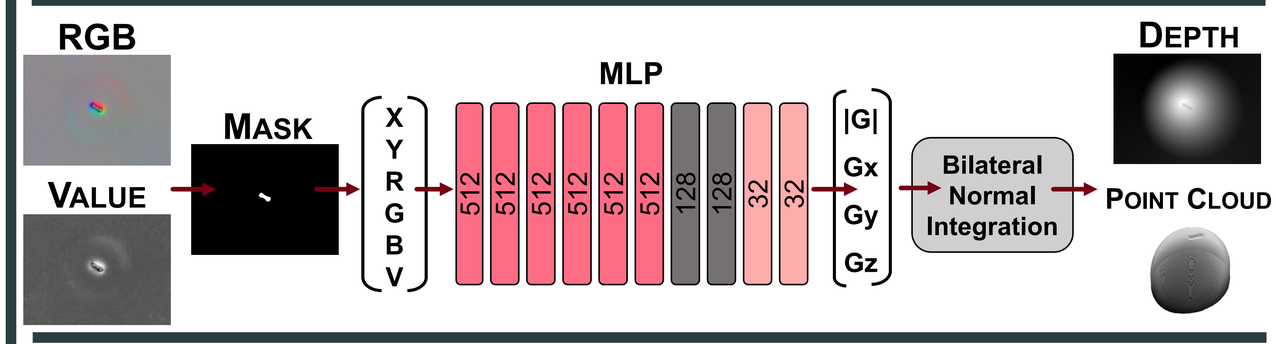
The **generalizability** of our method is shown by building both **omnidirectional** and **half-curved sensor shapes**. **No further illumination tuning** is necessary to obtain good tactile images.



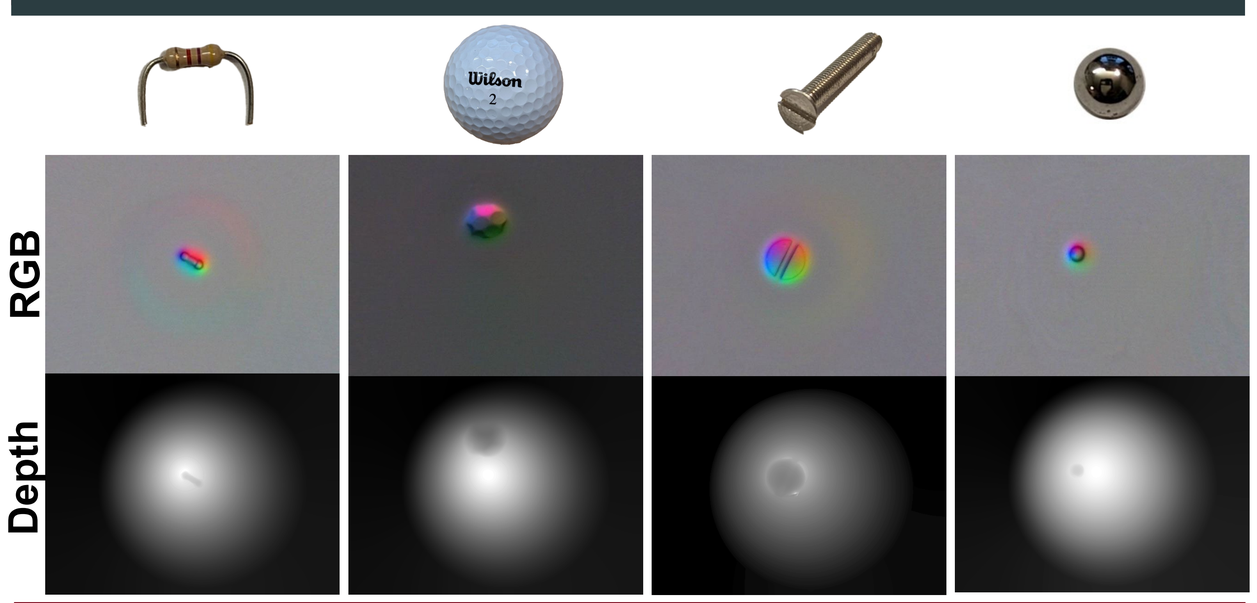
Sensor Calibration



Depth Reconstruction Pipeline



Results



	RGB IMAGE	DIFFERENCE IMAGE	RMSE LOSS	EPOCHS
RainbowSight			0.0529	120
Red-Green-Blue Lighting			0.0575	200
Green Lighting			0.0959	150
GelSight360			0.0872	85

Compared to previous illumination schemes, our method offers **better normal estimation** with **fewer training epochs** and **no occlusions** to the sensor surface.