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Augmenting Off-the-Shelf Grippers with Tactile Sensing

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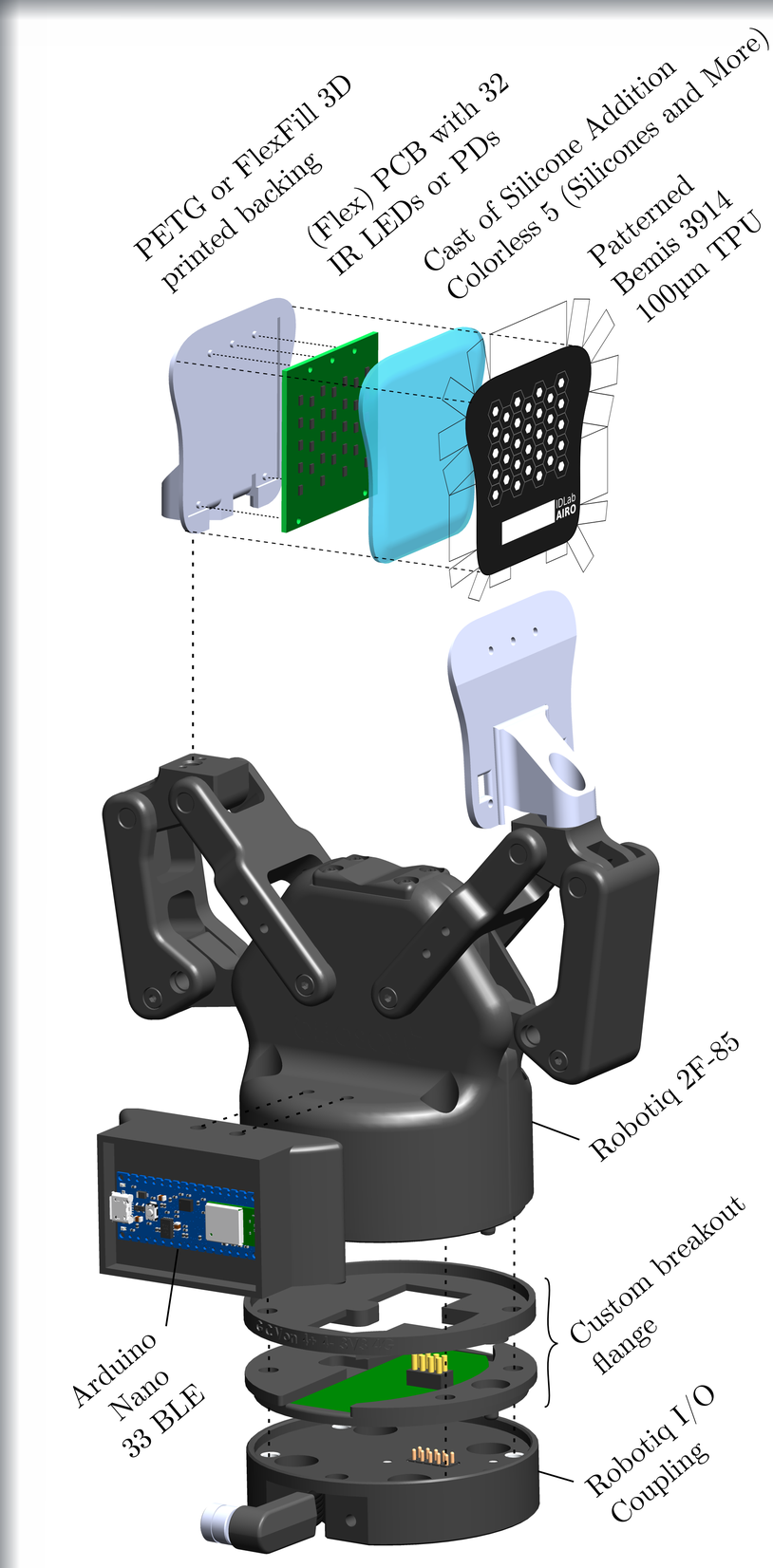
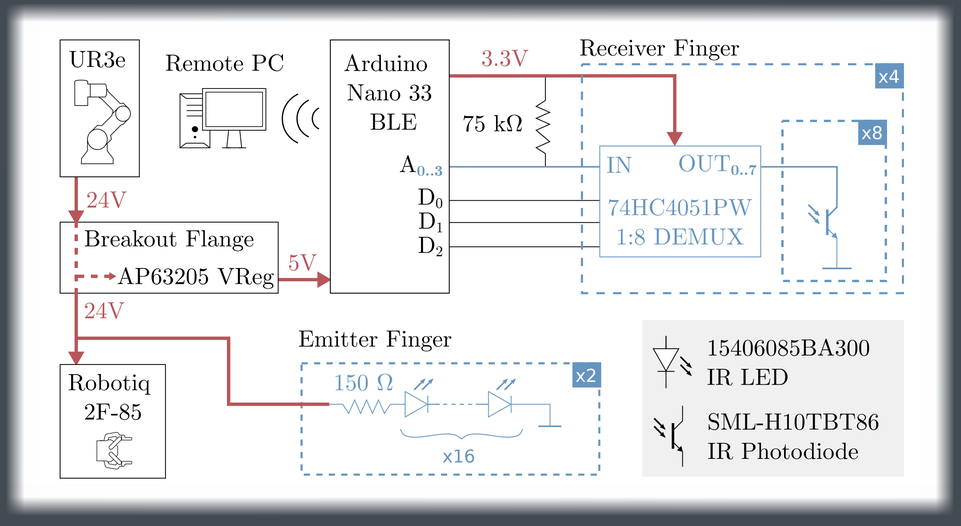
Tactile sensing and its fusion with computer vision will allow robots to perform complex tasks like deformable object manipulation. However, readily available grippers lack tactile feedback, leading to a wide range of custom sensor hardware in literature. This makes it difficult to compare task performance. We highlight the value of accessible open-source sensors, facilitating task transferibility through hardware transferibility, and present a set of fingertips specifically designed for fine object manipulation.



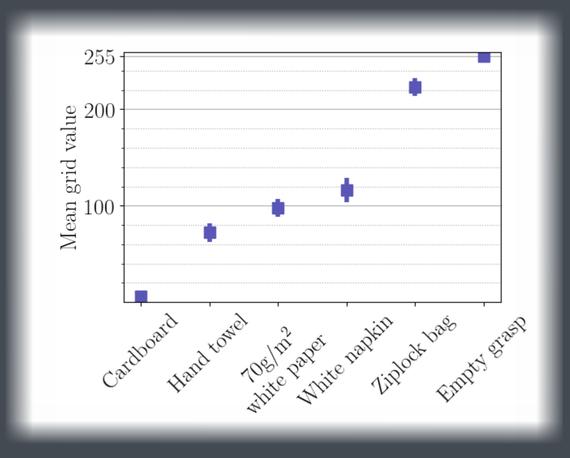
Design

Designing tactile sensors to be fingertips has the benefit of more easily switching out different designs, at low cost. Our tactile fingers are a complementary set: the first finger has a grid of infrared (IR) emitters, the second a grid of IR receivers. An Arduino reads the received light intensities and communicates this data over BLE. Both the fingers and the Arduino are mounted on a Robotiq gripper and powered via a custom breakout flange that provides access to the power source of the gripper. Manufacturing the fingers only requires standard lab equipment like a 3D printer and a heat gun. By using flexible filament for 3D printing and a flex PCB, the fingers can be made compliant, which is exceptionally useful for e.g. sliding underneath cloth to grasp and fold it.

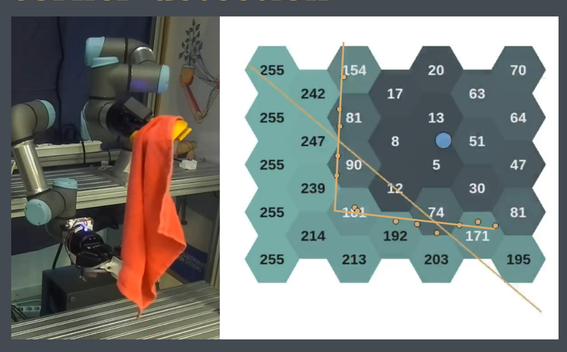


Validation

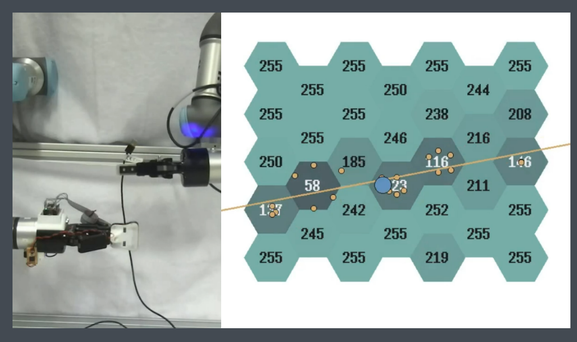
Interpreting the sensor output is straightforward: wherever the grid is dark, an object is present. The value of "dark" cells will, however, vary with object translucency and thickness. We have shown that a well-calibrated sensor can even detect a clear plastic ziplock bag.



Cloth edge tracing and corner detection



Cable tracing



The fingertips are validated through two difficult tasks: cloth edge tracing and cable tracing. To this end, two control parameters are derived:

(1) The centre of the dark cluster, used to keep the object about halfway between the fingers.

(2) The shape of the border between the dark and bright cluster, used for corner detection as stop condition when tracing a cloth edge. The border shape is parameterised by first placing edge markers at transition points between bright and dark clusters, to which piecewise linear functions are fitted.

As the control policy strongly relies on the sensor data, it transfers well to any robot that can mount the sensors.

How can we further alleviate the overhead of task and hardware transfer? Which tactile sensor would bring your robotic manipulators to the next level?

Future work

- Integrate MCU and electrical safety circuits in custom breakout flange to replace both the Arduino and the Robotiq I/O Coupling
- Optimize manufacturing method and employ more robust polymer for casting

Acknowledgement

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