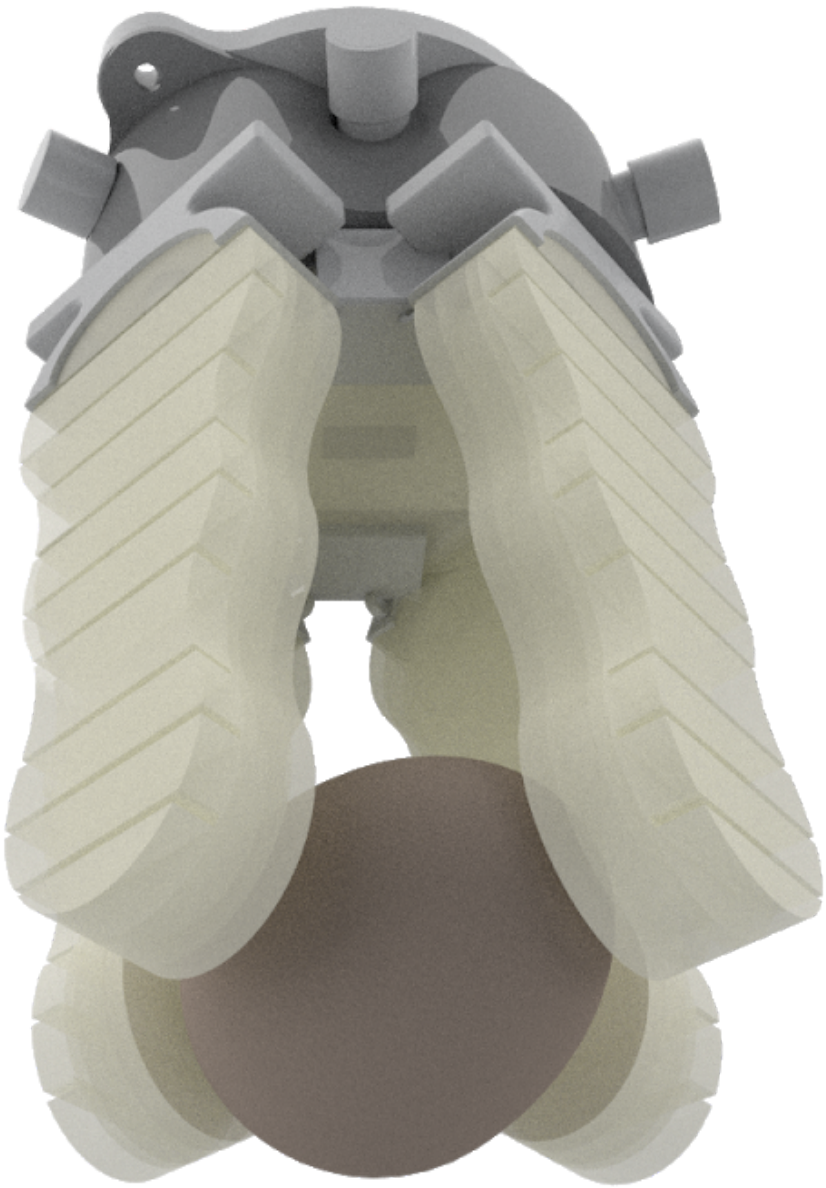
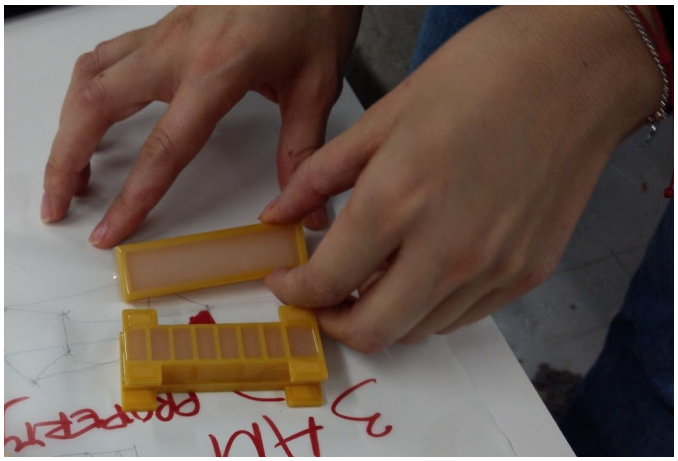
01. SOFT ROBOTICS FINGERS



1. Design your mould using the attached grasshopper file, or download the 3D printing-ready files from the attached Rhino file.

Make sure to add a T-shaped end to the beginning of your air channel in order to later attach the fingers to the robot connection module.

2. 3D print your mould (photo above)
3. Mix the two parts of Eco-flex 00-50 silicone according to the instructions on the packaging.
4. Pour the silicone in the bottom mould, up to the lip.
5. Pour the silicone in the main body mould, up to the lip. Then, place the spacer mould on top, making sure the indents are sunk in the silicone poured in the main body mould.

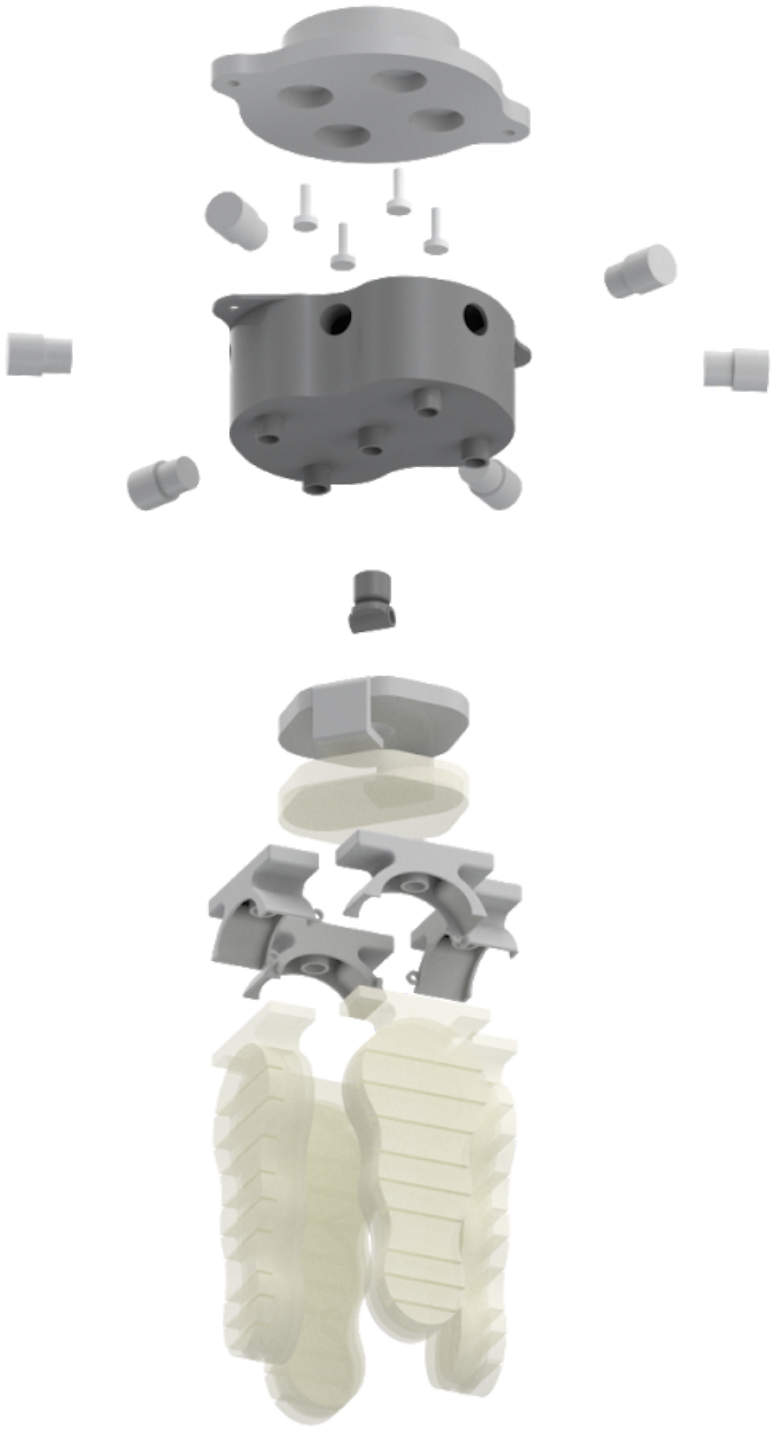


6. Leave the moulds to dry for at least 2 hours before carefully de-moulding.
7. Glue the bottom mould to the main body mould by applying a thin layer of silicone on the edges of the bottom mould and then placing the main body mould on top. Apply extra silicone on the vertical walls around the seam if needed to tightly close the mould.

8. Once the mould is dried in its final shape, pierce the air channel of the moulds with the syringe needle and test if the mould is inflating.

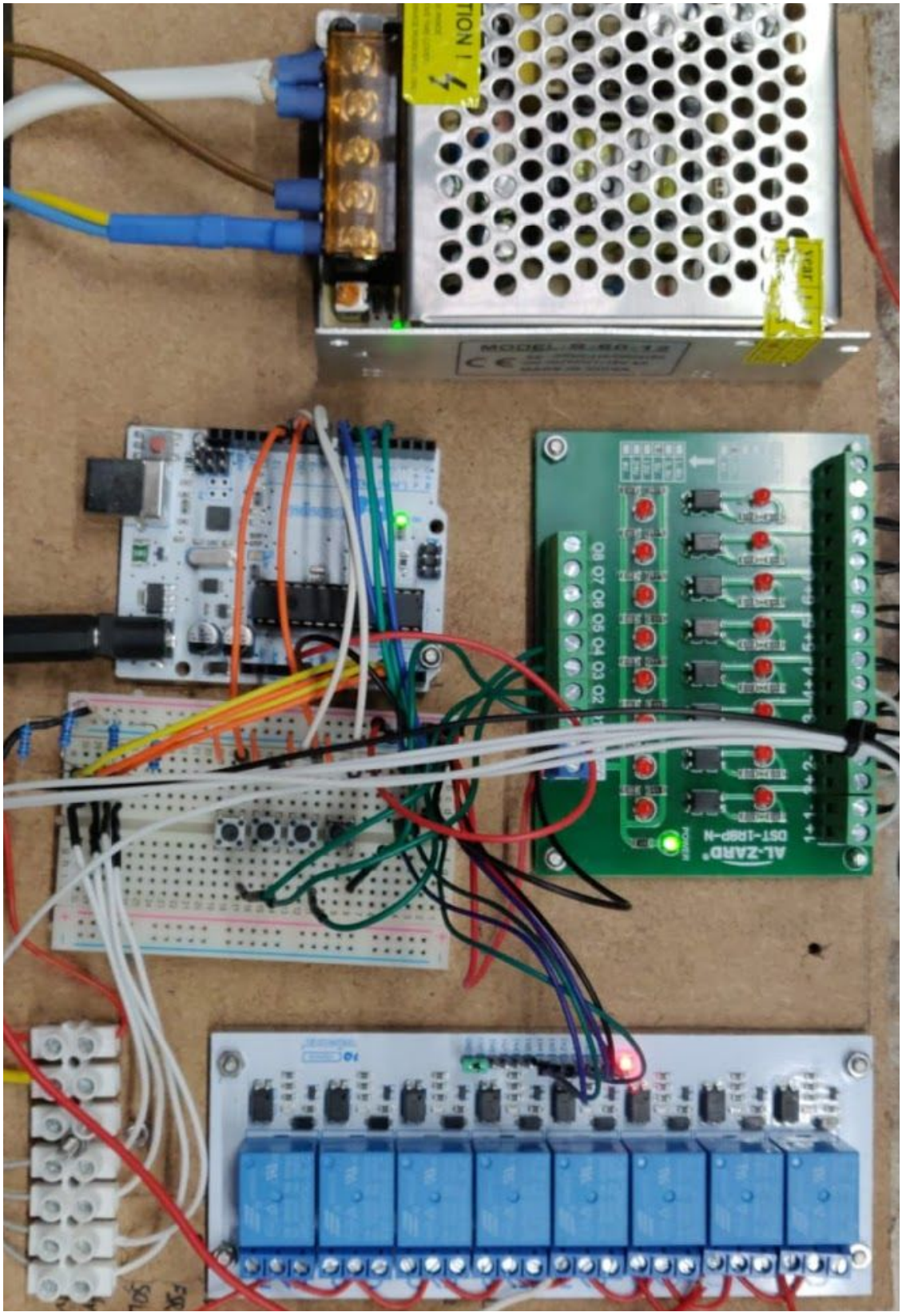
9. Repeat the process four times, for each one of the fingers, as well as for the knuckle spacer.
10. Attach the force pressure sensor to one of the fingers. (for this prototype in particular, we used superglue to fix it to the silicone)

02. CONNECTION TO ROBOTIC ARM



1. Download the Rhino file for the robot arm connection and 3D print it.
2. First screw in the robot arm connection plate using bolts compatible to the specific robot arm you are working with
3. Assemble the finger connections around the fingers
4. Attach the spacer connection plate to the silicone spacer and adhere it to the air chamber
5. Fix each finger connector in place on the air chamber using an adhesive
6. Attach the air chamber to the connection plate using the bolt tabs.
7. Insert the air connector into the air chamber using teflon tape

03. HARDWARE AND CONTROL SIGNALS



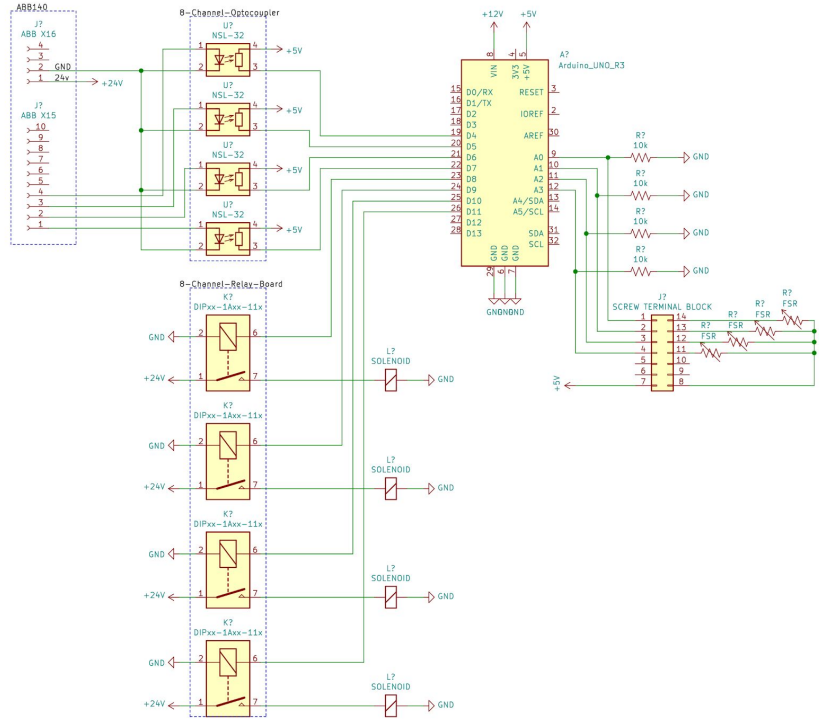
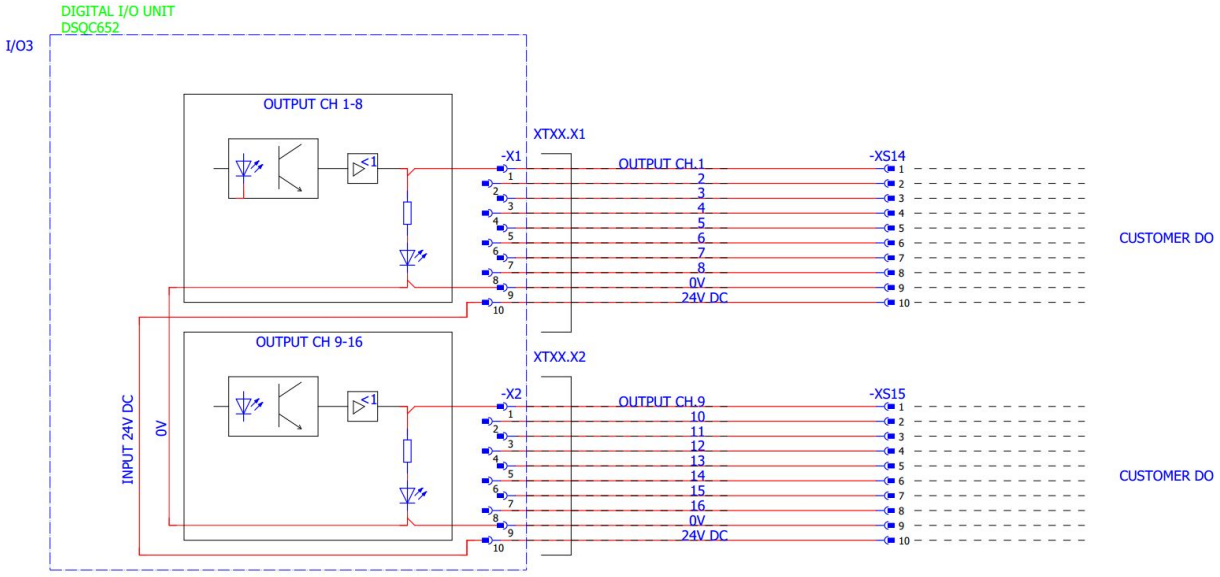
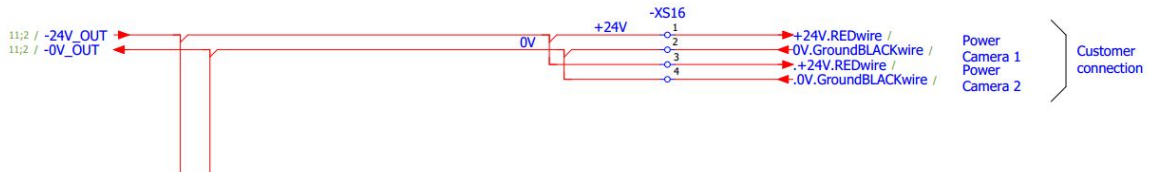


ABB140
J?
ABB X16
GND
24v
+24V
J?
ABB X15
8-Channel-Optocoupler
U?
NSL-32
+5V
A?
Arduino_UNO_R3
+12V
+5V
GNDGNDGND
R?
10k
GND
J?
SCREW TERMINAL BLOCK
R?
FSR
8-Channel-Relay-Board
K?
DIPxx-1Axx-11x
L?
SOLENOID
+24V


DIGITAL I/O UNIT
DSQC652
I/O3
OUTPUT CH 1-8
OUTPUT CH 9-16
XTXX.X1
XTXX.X2
-X1
-X2
-XS14
-XS15
OUTPUT CH.1
OUTPUT CH.9
0V
24V DC
INPUT 24V DC
0V
CUSTOMER DO
CUSTOMER DO


11;2 / -24V_OUT
11;2 / -0V_OUT
0V
+24V
-XS16
+24V.REDwire /
0V.GroundBLACKwire /
+24V.REDwire /
0V.GroundBLACKwire /
Power
Camera 1
Power
Camera 2
Customer
connection

1. First, the robot sends signals from its digital IO's. This prototype used an ABB IR140, using the X15 and X16 ports for power and signals. (See diagram).
2. The 24v robot DO signal from X15 passes through an optocoupler to provide a 5v signal to the microcontroller. This lets the microcontroller know what state the program expects each air chamber to be in.
3. Each chamber (the fingers or the knuckles) can be in three states (either inflating, held, or deflating). Thus there are two signals (and two solenoids) running for each chamber. The first (closer to the air chamber) determines whether the chamber is currently held or is changing. The second determines the direction of change (either connected to the air supply to inflate or connected to open air to deflate).
4. However, the gripper still shouldn't inflate continuously, so its state is also modulated by signals from force sensitive resistors on each of the fingers. These signals are combined with internal timers in the microcontroller to only inflate by controlled amounts.
5. The microcontroller output signal then passes through a relay which switches the 24v supply from X16 on the robot. This signal then connects to the air solenoids to supply or remove air to the gripper.