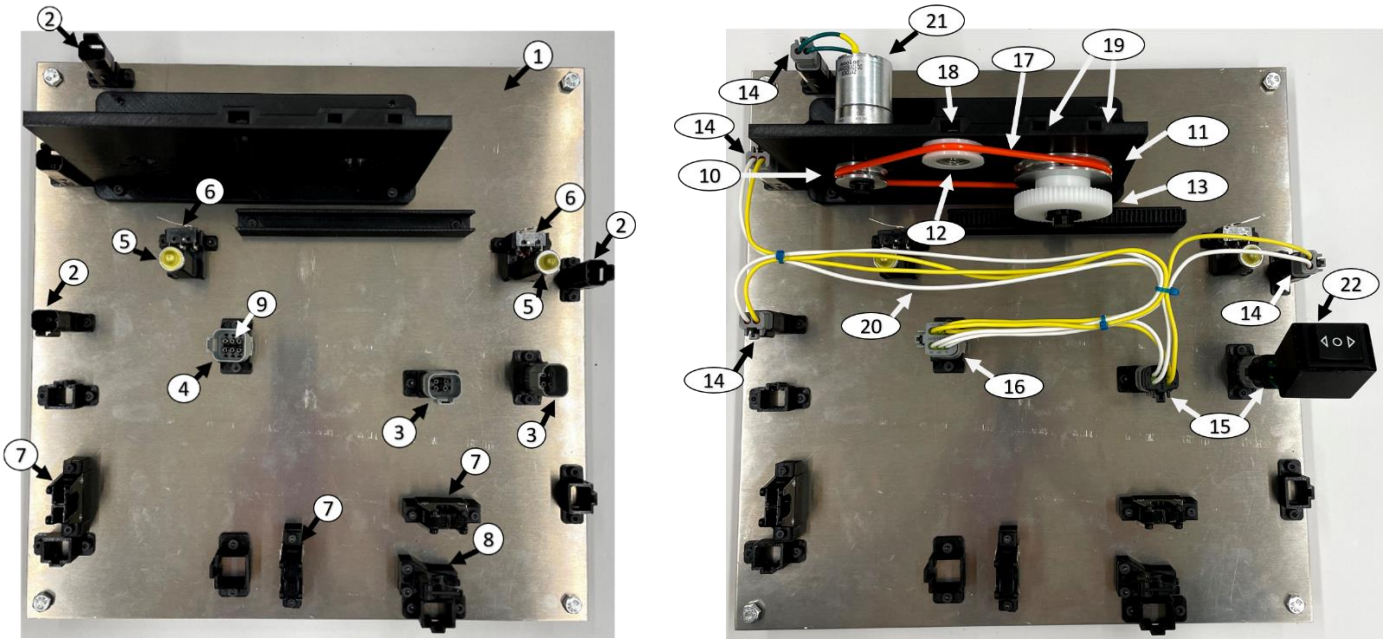
Instructions to Produce an IROS 2021 Manufacturing Track Practice Task Board

This document conveys fabrication instructions for assembling the practice task board for the Manufacturing Track of the IROS 2021 Grasping and Manipulation Competition. All major components are identified figures 1 and 2 below.



(a) Disassembled (b) Assembled

Figure 1. Identification of key components as labeled in the subsequent parts list and their locations on the task board.

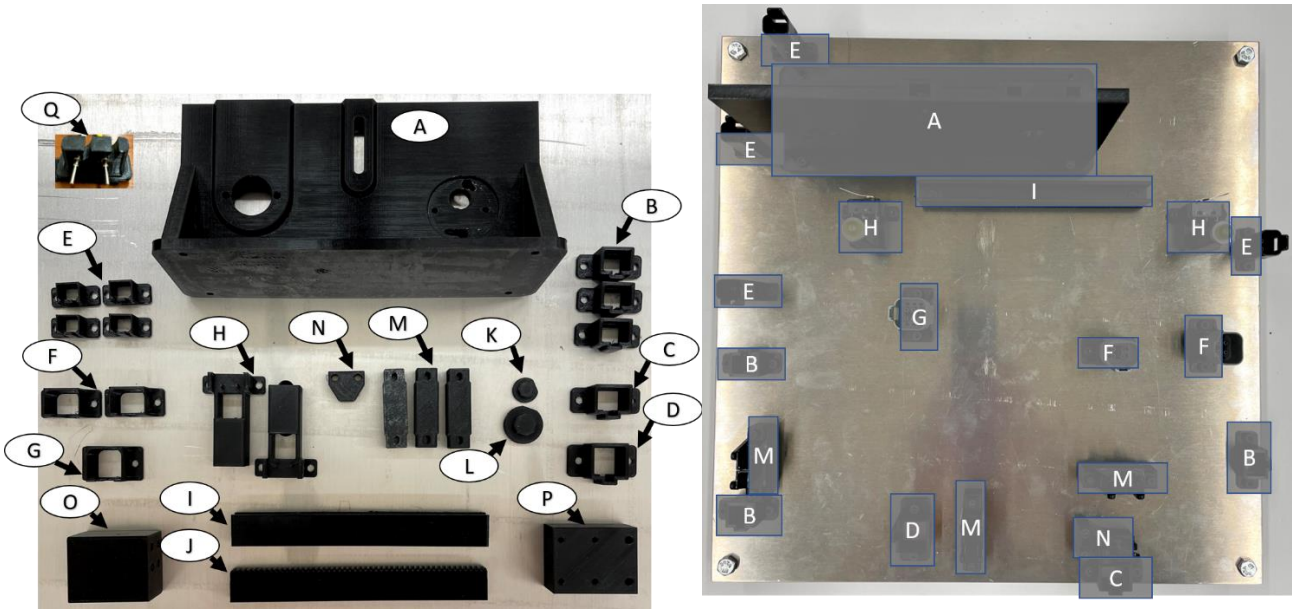


Figure 2. 3D printed parts and their locations

Purchasing:

1) Majority of parts specified based on availability through a limited number of vendors to reduce complexity when ordering parts. Vendors used: Misumi, Allied, Vertical, Newark and Amazon. Other vendors may supply the same parts. Note that this task board uses many parts from the NIST Assembly Task Boards (ATB) found at https://www.nist.gov/el/intelligent-systems-division-73500/robotic-grasping-and-manipulation-assembly/assembly.

2) The aluminum task board base was machined at NIST shops and is provided to teams for practice and competition by NIST. CAD files (provided by NIST) can be used to machine a task board base through outside vendors though quality cannot be guaranteed in this case.

Disclaimer: Certain commercial equipment, instruments, or materials are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Parts List- IROS 2019 Practice Task Board

(Example)

ID	Item	Vendor	Part Number	Unit
1	Task Board Base (NIST provided)		N/A	1
2	2 socket deutsch connector Female	wirecare	AT04-2P	3
3	4 socket deutsch connector Female	wirecare	AT04-4P	2
4	6 socket deutsch connector Female	wirecare	AT04-6P	1
5	Indicator LED (red or yellow)	Newark	1091M1-12V	2
6	Limit switch	Misumi	SS-5GL111	2
7	Bearing for hinge pin	Misumi	BGCBB6800ZZ-20	1
8	Hinge Pin	Misumi	SHCLSG10-60-E40-F0	1
9 a	Round Socket 16-20 awg	wirecare		22
9 b	Round PIN 16-20 awg	wirecare		22
10	Round belt pulley (30mm nominal dia.)	Misumi	MBRF38-3-P6	1
11	Round belt pulley (50 mm nominal dia.)	Misumi	MBRF60-3-H10	1
12	Round belt pulley with bearing (35 mm OD)	Misumi	EUBHS35	1
13	Plastic toothed gear	Misumi	GEABP1.0-60-10-B-10	1
14	2 pin deutsch connector Male	Wirecare	AT06-6S	3
15	4 pin deutsch connector Male	wirecare	AT06-4S	2
16	6 pin deutsch connector Male	wirecare	AT06-2S	1
17	Polyurethane round belt (4mm dia. – 400 mm length)	Misumi	MBT6-140	1
18	M6 Square Nut (10mm x 10mm x 5mm – pitch 1.0 mm)	misumi	NSQA-SUS-M6	1
19	M4 Square nut	misumi	NSQA-SUS-M4	2
20	16 AWG stranded wire variety pack (100ft)	*	N/A	1
21	12V DC motor 20 RPM	Amazon	N/A	1
22	Momentary Rocker switch	newark	R5DBLKBLKHF0	1
N/A	M4 Socket Cap Screw (10 mm length -pitch 1.0 mm)	*	N/A	36
N/A	M3 Socket Cap Screw (20 mm length -pitch 1.25 mm)	*	N/A	6
N/A	M3 Socket Cap Screw (6 mm length -pitch 0.5 mm)	*	N/A	2

N/A	Plug in 12V power source	newark	58-18265	1
N/A	Wedge lock for 2 pin connector	allied	AW2P	4
N/A	Wedge lock for 4 pin connector	allied	AW4P	2
N/A	Wedge lock for 6 pin connector	allied	AW6P	1
N/A	DC barrel socket connector	newark	Clb-jl-53	1

* Choice of supplier if specifications are met. Part numbers provided are associated with us.misumi-ec.com

Parts to 3D Print

ID	Part/Description	File Name	Unit
A	Mounting Plate	BeltDrive_L_Mounting_Plate 3.STL	1
B	Male 2pin deutsch connector housing	ATP 2pin housing short.STL	3
C	Male 4pin deutsch connector housing	ATP 4pin housing short.STL	1
D	Male 6pin deutsch connector housing	ATP 6pin housing short.STL	1
E	Female 2pin deutsch connector housing	ATP 2pin housing F.STL	4
F	Female 4pin deutsch connector housing	ATP 4pin housing F.STL	2
G	Female 6pin deutsch connector housing	ATP 6pin housing F.STL	1
H	Limit switch and LED housing	LimitSwitchHousing_withLED v2.STL	2
I	Linear rack	Linear gear.STL	1
J	Linear rack guide	linear rack guide v2.STL	1
K	Press fit cap motor shaft	Pressfit motorshaft cap.STL	1
L	Press fit cap Hinge Pin	Pressfit pin cap.STL	1
M	Elastic retainer stool	Elastic retainer stool.stl	3
N	Corner post stool	cornerpost Stool.STL	1
O	Rocker switch housing	Rocker switch housing.STL	1
P*	Bolt holder	Bolt holder.STL	1
Q*	Wire rack	Wire rack.STL	3

* Indicates optional parts

Tools List

1) 5mm hex key
2) 3mm hex key
3) Deutsch round pin Crimper
4) Wire cutters
5) Wire strippers
6) Small flat head screwdriver
7) Soldering Iron
8) Heat gun
9) Shrink wrap tubing

Assembly Instructions

3D printed materials:

1) Place the “elastic retainers” on top of the printed “Elastic retainer stool” and align them with the M3 tapped holes on the task board base according to Fig. 1. Use long M3 bolts to secure the retainer and stool to the board.
2) Place the “Corner post high” on top of the printed “cornerpost Stool” and align it with the M4 tapped holes on the task board base according to Fig. 1. Use long M4 bolts to secure the retainer and stool to the board.
3) Leave the LimitSwitchHousing, Rocker Switch Housing, Linear gear, Bolt holder, and Wire rack aside for now.
4) Place each of the remaining printed parts in their locations according to Fig 1. Mounting plate, linear rack, and each of the connector housings. Use M4 bolts to secure to the board. Be sure to check the orientation of each part as they can easily be rotated 180 degrees on accident.

Task Wire preparation:

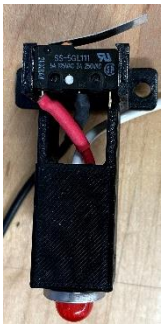
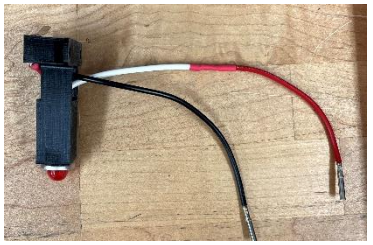
1) Cut 1 red wire and 1 black wire of the following lengths (8 total wires):
    a. 9 inch (~23cm)
    b. 18 inch (~46 cm)
    c. 13 inch (~33 cm)
    d. 20 inch (~51 cm)
2) Strip the ends of each wire (5mm), add male pin to both ends of wire, and crimp


Board fabrication wire preparation:

1) Cut Green wires to the following lengths
    a. 6 wires at 8cm long
    b. 10 wires at 10cm long
    c. 6 wires at 20cm long
    d. 2 wire at 4cm long
2) Cut 5mm off each end of the wire to expose the multi thread core.

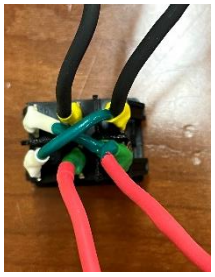
Limit Switch with LED fabrication:

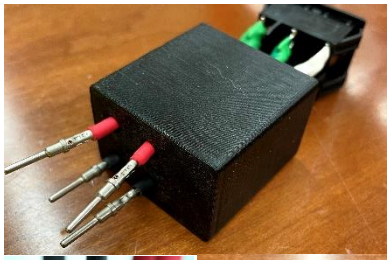
1) Using the images to the right as reference: On the LED, snip each of the colored wires to their shown lengths.
2) Feed the LED through the limit switch Housing printed part
3) Insert the limit switch into the housing onto the pegs. One limit switch one direction the other switch the opposite direction.
4) Slide appropriately sized shrink wrap tubing on each wire of the LED.
5) Solder the short end of the LED to the terminal labeled 1. This will be the terminal that is closest to the joint of the lever arm.
6) Solder a 20cm green wire to the terminal labeled 3. This will be the middle terminal.
7) Heat and shrink the tubing on each of the terminals.
8) Splice an 8cm wire to the other end of the LED to extend its length. Solder and heat wrap the bind.
9) Crimp female sockets to each end of the 2 exposed wires.
10) Feed the wires through the task board at their locations and attach the housing to the board using 4mm screws.

Rocker switch fabrication:

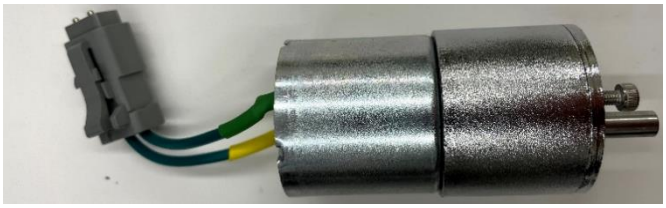
1) Take 4 of the 10cm wires and crimp a male pin to one end of each.
2) Slide a small piece of shrink wrap tubing on to the 10cm wires.
3) Using the images to the right for reference:
    a. take 2 4cm green wires solder them to 2 corner terminals of the rocker switch.
    b. Add a small piece of shrink wrap tubing to the wires.
    c. Cross the wires as shown in the images.
    d. Slide the other ends of the 4cm wires through the shrink wrap tubing on 2 of the 10 wires. Slide the tubing up to expose the ends of the wires.
    e. Solder the other ends of the 4cm wires to the opposite corner terminals of the rocker switch



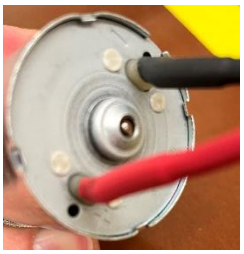


4) Solder the 10cm wires to the same opposite corners of the rocker switch pairing them with the 4cm wire and slide the shrink wrap down over the terminal.
5) Solder the remaining 10cm wire to the middle terminals of the rocker switch and slide the shrink wrap over these terminals as well.
6) Heat all connections to shrink the tubing around each terminal.
    a. Note: it is useful to add red and black shink wrap tubing to the wire to color coordinate one side from the other, as shown in the images.
7) Slide the 4 wires through the rocker switch housing and enclose the rocker switch terminals within the housing.
8) Press each of the wire pins into a AT04 male connector making sure not to cross wires. Take special note of the orientation of the connector and the color of the wires entered into each side of the connector.

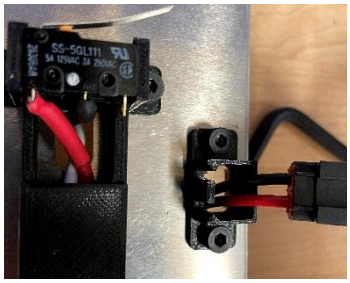
<u>Motor with connector fabrication</u>



1) Use 2 of the 8cm green wires to solder and shrink wrap each end to the terminals located on the back of the motor.
2) Crimp 2 male pins to the other end of each wire.
3) Feed the pin ends of the wires into a AT02 male connector. Press until a click is heard.
4) Take 2 of the 20cm green wires and crimp female sockets on to both ends of both wires.
5) Feed the wires through the task board at the AT02 female connector locations at the top of the board.
6) Press the wires into the ends of the female AT02 connectors until they click and seat the connectors back into their housings.

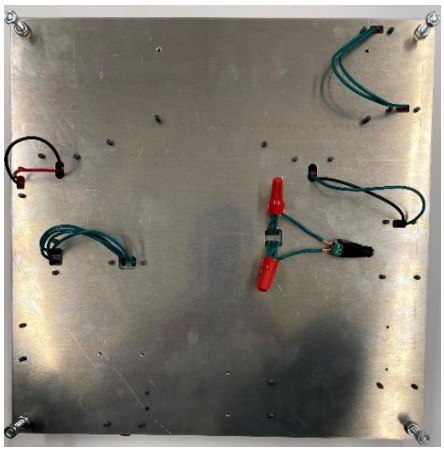


<u>Task board connections:</u>



7) Limit switch connection:
    a. Feed each of the wires from the limit switch housings up through the task board at the male AT02 connectors and press them into the slots of the connector until they click. This may take some fidgeting.
    b. Insert the wedge-lock associated with the AT02 pin connector. Do this for both limit switch and AT02 pin locations.

8) 12V power supply connection:
    a. Crimp female sockets on 6 of the 10cm green wire and feed them through the board at the AT06 connector location. Press each of the 6 wires into the connector until the click.
    b. Using a wire nut splice the 3 left side 10cm wire together with one 8cm wire. Use a separate wire nut to splice the other 3 right side wires with another 8cm wire.
    c. Feed the other end of each 10cm wire into the barrel socket connector and plug the connector into the 12v power supply



Underside of task board showing wire connections

Note: It can be useful to glue each of the female AT series connectors to their housings once the wiring is complete to reduce any separation of parts during operation.

Standoffs:

1) Connect the two threaded aluminum strips with Velcro to two corner holes of the board using the two M6-35mm hex bolts on opposing sides as shown in Figure 1. Tighten one nut to the strip and the other to the board.

Please contact Kenny Kimble (kenneth.kimble@nist.gov) or Joe Falco (falco@nist.gov) with any questions regarding the production of this task board.