

Manipulation Tasks

(* All rules and objects are subject to change due to availability, space limitation, time constraints, etc.)

The competition tasks listed here are for both tracks: hand-in-hand grasping track and fully autonomous track.

There will be total 10 tasks in the competition. The exact 10 tasks will be revealed to the teams two days before the competition. They will be selected from a pool of 18 tasks. Nine of the 18 tasks are provided in this description.

The tasks are separated to four levels of difficulties. Tasks in different levels of difficulties are worth different points. A task in level 1 is worth 10 pts, a task in level 2 is worth 20 pts, a task in level 3 is worth 30 pts, and a task in level 4 is worth 40 pts. In the competition, there are four available tasks in level 1, three in level 2, two in level 3 and one in level 4. The total possible points are 200.

The tasks in the competition will be randomly selected from the task pool (including the given tasks and the ones that are not given).

The tasks are diverse and many of them are very difficult. The contestants are not required to complete all the tasks to win.

Level 1 (10 pts each)

1. Use a spoon to pick up peas

Items:

1. 20 green peas similar to the peas in the link
https://www.amazon.com/Food-Live-Green-Vatana-Pounds/dp/B00L0MAM8W/ref=sr_1_1_s_it?s=grocery&ie=UTF8&qid=1468454021&sr=1-1&keywords=peas
2. Spoon
https://www.amazon.com/gp/product/B0009PUR86/ref=oh_aui_search_detailpage?ie=UTF8&psc=1
3. Plates
https://www.amazon.com/gp/product/B0009PUR86/ref=oh_aui_search_detailpage?ie=UTF8&psc=1

Competition setup:



Figure 1: A half-full bowl with peas and an empty plate are placed 10 inches apart on a table. The cup, bowl, and plate.

1. A 6-inch bowl is half full with green peas.
2. A 10-inch plate is located 10 inches to the right of the bowl.
3. A spoon is placed in a cup with the spoon's handle out. The location of the cup can be defined by the contestants.

Competition:

1. Grasp the spoon from the cup
2. Pickup peas from the bowl
3. Transfer the peas to the plate
4. If needed, the robot can repeat multiple times.
5. Successfully transferring each pea is worth 2 pts until reach to 10 pts.
6. The competition is terminated if the robot knocks over any object.
7. Dropping peas outside of the plate is allowed.

2. Use a spoon to stir water in a cup

Items:

Spoon and cups are the the same as used in Task 1.

Setup:

A spoon is placed in a cup with the spoon's handle out. The location of the cup holding the spoon can be defined by the contestants.

Competition:

1. The robot picks up the spoon in the empty cup
2. Submerge the bowl of the spoon in the other cup half-full of water
3. Stir water using the bowl of the spoon for two cycles. Completing each cycle gains 5 pts.
4. The competition is terminated if the cup is tipped over.
5. 3 pts will be reduced if any water is spilled

3. Shake out salt from a salt shaker to a defined location

Items:

1. Salt shaker: https://www.amazon.com/Farberware-Classic-Pepper-Shaker-2-Ounce/dp/B005NKJVGQ/ref=sr_1_10?s=home-garden&ie=UTF8&qid=1468517851&sr=1-10&keywords=salt+shaker
2. Salt: https://www.amazon.com/Morton-Iodized-Salt-26-oz/dp/B000Q3CJGO/ref=sr_1_4_a_f_it?ie=UTF8&qid=1468517913&sr=8-4&ppw=fresh&keywords=salt
3. Measuring cup
https://www.amazon.com/OXO-Grips-Angled-Measuring-Clear/dp/B00FYL4MPY/ref=sr_1_3?s=kitchen&ie=UTF8&qid=1468642150
4. Plate as in task 1.

Setup:

1. Salt shaker is prepared with 1 cup of salt and the salt shaker is mostly full.
2. Salt shaker is placed up-right on table surface
3. The contestant can decide the location of the plate

Competition:

1. Perform grasp of salt shaker
2. Shake salt shaker above the plate with the salt shaker being completely intact during the task
3. Dispensing 1/16 of cup of salt on the plate earn full points
4. The salt on the plate will be poured into the measuring cup to measure
5. Salt is allowed to be dispensed outside of the plate.
6. The salt shaker must remain intact during the entire test (teams are not allowed to take it apart)
7. Dropping shaker is allowed. However, if the robot cannot pick it back up, the competition is terminated.

Level 2 (20 pts each)**4. Grasp a plug and insert it into a socket****Items:**

1. Power Strip (w/ 2-AC outlets and 4 USB charging ports)
https://www.amazon.com/gp/product/B016OVD668/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=A2VRWFTK1O6VGO
2. Industrial VELCRO – adhesive backed
https://www.amazon.com/gp/product/B00006RSP1/ref=ox_sc_act_title_3?ie=UTF8&psc=1&smid=ATVPDKIKX0DER
3. One AC night light
https://www.amazon.com/gp/product/B00PU2TN0Q/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=AS8F55Q7LYHA9
4. One USB night light
https://www.amazon.com/gp/product/B0191S9I4K/ref=ox_sc_act_title_2?ie=UTF8&psc=1&smid=A1KKVWVMYDW8DT

Setup:

1. Mount the power strip to a surface using the VELCRO tape and plug into an AC power source.
2. Plug one AC night light into one outlet of the power strip.
3. Manually plug one USB light into one USB port of the power strip.

Competition:

1. Extract the both lights completely from the outlet. (If plug cannot be removed, consider loosening them in order to proceed to the next step)
2. Grasp and plug one light at a time into the sockets to minimum depth for electrical contact.
3. Scoring is based on the following for each plug:
 - a. Light removal - 5 points per light
 - b. Light insertion (light on) - 5 points per light

5. Hammer a nail

Items:

1. Smooth Foam 2" x 4" x 12"
https://www.amazon.com/gp/product/B00A2GIV80/ref=ox_sc_act_title_7?ie=UTF8&psc=1&smid=ATVPDKIKX0DER
2. 10D 3-Inch Common Nails – 1 pound
https://www.amazon.com/gp/product/B000BQUGBG/ref=ox_sc_act_title_5?ie=UTF8&psc=1&smid=A1NAIB2K0ZQEK
3. YCB hammer
<http://www.harborfreight.com/16-oz-claw-hammer-66862.html>

Setup:

1. Set hammer at predefined table location with handle overhanging table (figure 2)
2. Fix smooth foam to table top at defined location with 2"x 12" surface on table (figure 2) – can be flipped for additional tests.
3. Mark nail locations on foam per (figure 2).
4. Mark 3" nails with a 1" and 2" depth
5. Set nail in next location per test push to 1" depth.

Competition:

1. Grasp hammer at predefined location.
2. Position hammer at nail location and drive nail to full depth.
3. Repeat for 4 nails
4. Scoring based on the following:
 - a. Drive nail with hammer face (see figure 2) to within 1" of nail protruding out of foam – 2 points per nail **-or-**
 - b. Drive nail to full depth (head flush with foam) – 5 points per nail

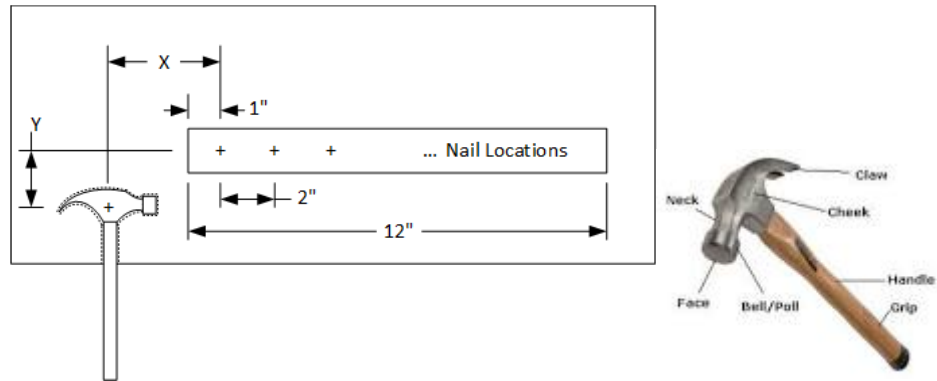


Figure 2: Hammer A Nail Setup

6. Transfer straw into a to-go cup with lid

Items:

1. Straws
https://www.amazon.com/Smoothie-Straws-Extra-Assorted-Colors/dp/B001R3JL5C/ref=pd_sim_sbs_79_3?ie=UTF8&dpID=510YB6zbJhL&dpSrc=sims&preST= AC UL160 SR160%2C160 &psc=1&refRID=A8DKCNHNPT9KB99X8F5A
2. Cup with lid
https://www.amazon.com/World-Deals-Plastic-Clear-Flat/dp/B010JQLKSA/ref=pd_sim_79_5?ie=UTF8&dpID=41DcNm7awGL&dpSrc=sims&preST= AC UL320 SR238%2C320 &psc=1&refRID=WMBB9GZTH6XYRV2FJKRG
3. A cup in task 1.

Setup:

1. The straws are packed fairly tightly in one upright cup.
2. Another cup has a lid on it, placed upright and 30 cm to the side of the cup holding straws.
3. The cup with lid is full of water

Competition:

1. The robot picks up one straw from the cup
2. Place it into the straw hole while keeping the cup upright to earn full points
3. The location of the cup can be defined by the contestant.
4. The competition is terminated when the cup with lid is tipped over.
5. Dropping straw is allowed.

Level 3 (30 pts each)

7. Putting on or removing bolts from nuts with a nut driver

Items:

1. 2" x 4" x 6" length wood stud
2. E-Z Lok Threaded Inserts 1/4-20 and installation kit
https://www.amazon.com/gp/product/B015CAPI54/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=ATVPDKIKX0DER

3. Hex Bolt $\frac{1}{4}$ -20 x $\frac{3}{4}$ "
https://www.amazon.com/gp/product/B004S6RZPK/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=ATVPDKIKX0DER
4. Klein Tools 646-7/16-Inch Cushion-Grip Nut Driver
https://www.amazon.com/gp/product/B000WMTCZA/ref=ox_sc_act_title_3?ie=UTF8&psc=1&smid=ATVPDKIKX0DER
5. Drill bit sized for nut driver holding hole - TBD

Setup:

1. Manually drill holes and install E-Z Lock stud (This task could eventually be part of a future competition)
2. Fix 2 x 4 stud at predefined table location
3. Locate nut driver in locating hole on 2 x 4 stud (figure 3)
4. Mark bolt threads $\frac{1}{4}$ " from bottom surface of head.
5. Start bolt thread in 2 x 4 stud and apply 2 turns (figure 3)

Competition:

1. Grasp nut driver from predefined location in wood stud.
2. Drive bolt until fully seated.
3. Scoring based on the following:
 - a. Engage nut driver with bolt - 5 points
 - b. Drive bolt with at least 5 full turns – 10 points **-or-**
 - c. Drive bolt to full depth - 25 points

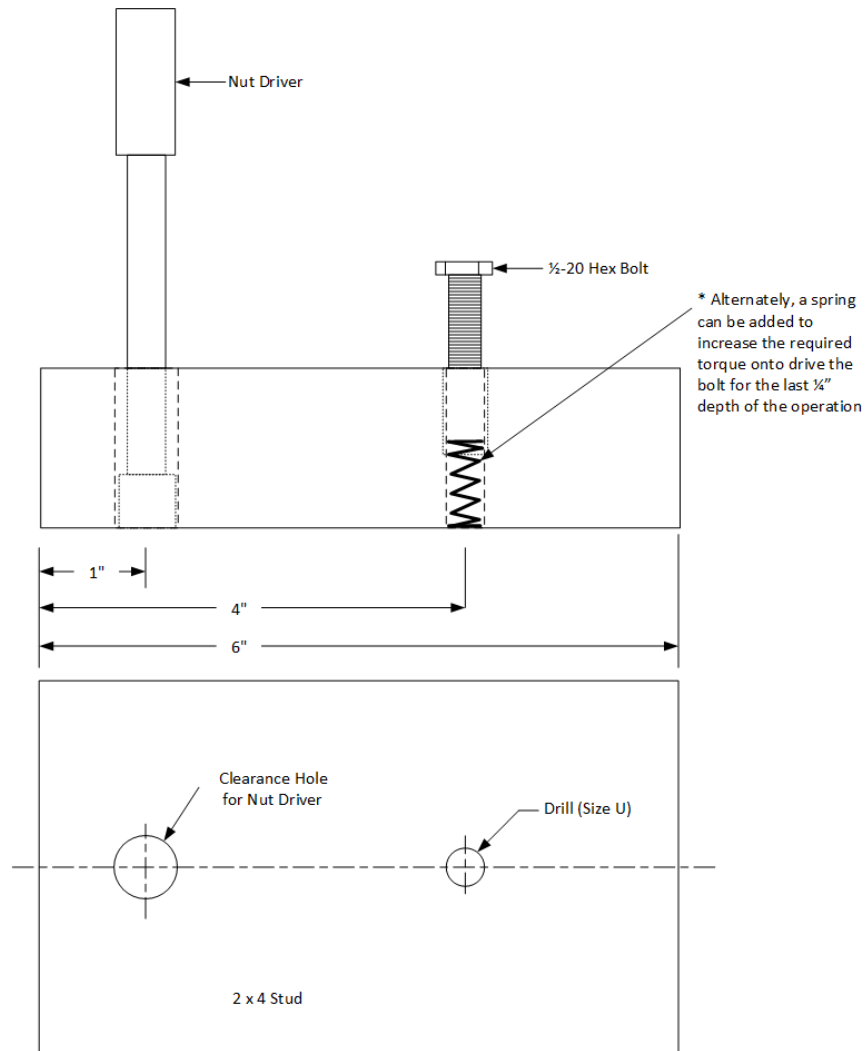


Figure 3: Apply Bolt with Nut Driver

8. Use a saw to saw open a cardboard along a line

Items:

1. Hand Saw (EverSaw 8.0) - https://www.amazon.com/gp/product/B00ZSWM1VQ/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=A2PM1N3XDWDKBE
2. Clear plastic 6 x 8 sign holders - https://www.amazon.com/gp/product/B00PZNFRL0/ref=ox_sc_act_title_2?ie=UTF8&psc=1&smid=A1MZXNKC5K689J
3. 100 Cardboard Filler Inserts - https://www.amazon.com/gp/product/B00YGPYT34/ref=ox_sc_act_title_3?ie=UTF8&psc=1&smid=AMUIFASFNM4P4
4. ACCO Large Binder Clips - https://www.amazon.com/gp/product/B002VD6BLG/ref=ox_sc_act_title_1?ie=UTF8&psc=1&smid=ATVPDKIKX0DER

Setup:

1. Align 2 sign holders with “1-2” space between them and fix to table top.
2. Mark cardboard filler insert with cut line at center in 8.5 direction and mark scoring at 1/3 of 8.5 intervals. See red dashed line in Figure 4.
3. Insert cardboard filler insert into sign holder with cut line centered and clamp using 4 binder clips as shown in figure 4.
4. Use left side of the sign holder to stage the saw for grasping blade cutting surface facing in towards cardboard for safety.

Competition:

1. Grasp Saw from staged location
2. Cut cardboard filler insert along cut line.
3. Scoring based on progress of cut over 8.5”
 - a. 1/3 of 8.5” - 10pts -or-
 - b. 2/3 of 8.5” - 20pts -or-
 - c. All of 8.5” – 30pts

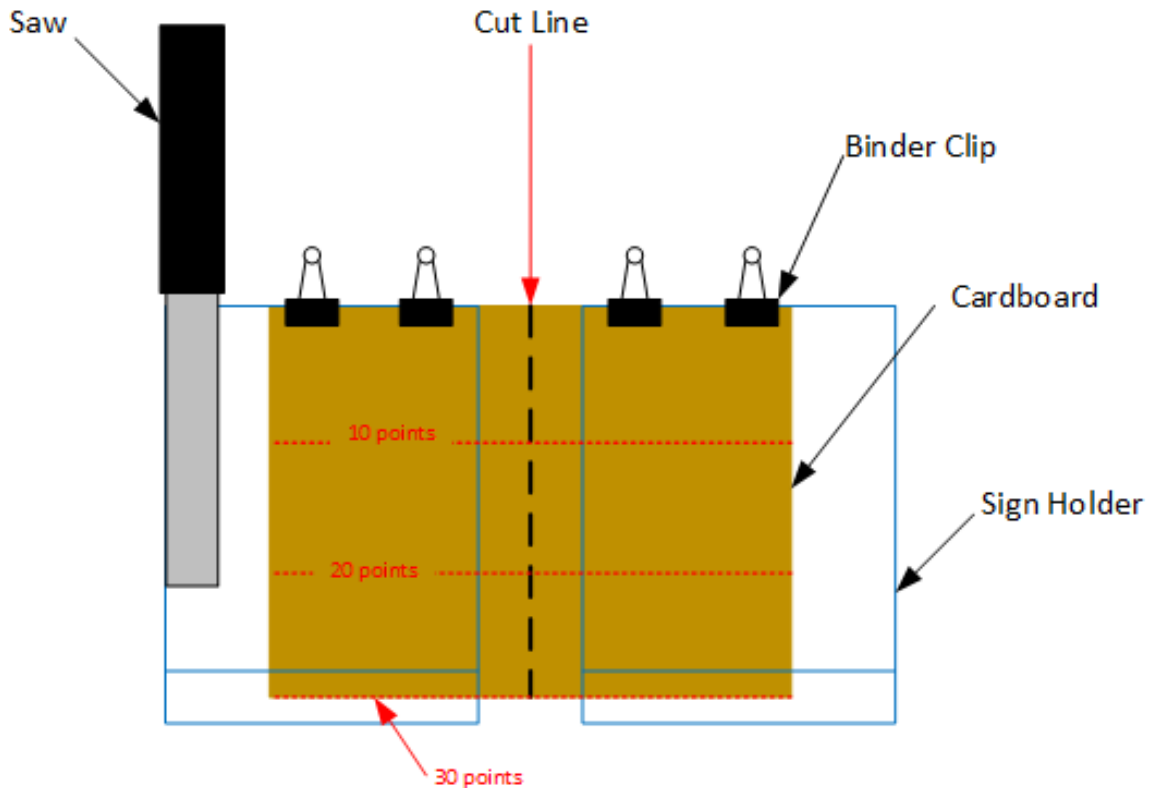


Figure 4: Use a saw to saw open a cardboard along a line

Level 4 (40 pts each)

9. Open a bottle with a locking safety cap (Push Down & Turn Caps)

Items:

1. 2” x 4” x 6” length wood stud

2. Pharmacy Vials 40 Dram - Snap Caps Vials with Safety Push and Turn Cap (40 DRAM, 6 PCS)

https://www.amazon.com/gp/product/B0198W55QY/ref=ox_sc_act_title_4?ie=UTF8&psc=1&smid=A1H3J68XZ5X5W7

Setup:

1. Attach bottle securely to 2x4 stud so that the attachment can withstand substantial twisting forces.
2. Place cap on bottle and twist to lock.
3. Fix 2x4 stud at predetermined location on table.

Competition:

1. Push and turn the cap of the bottle to unlock it.
2. Remove cap from bottle.
3. Scoring based on the following:
 - a. Cap is unlocked but not removed – half points
 - b. Cap is separated from the bottle completely – full points