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1 Competition Overview

Fetch Robotics is organising FetchIt! - A mobile manipulation challenge at ICRA 2019, in Montreal, QC, Canada. The goal of the competition is to have a Fetch Mobile Manipulator autonomously assemble “kits” by navigating to stations in a work cell, picking up items, operating basic machinery, placing items into kits and transporting the finished kits to a drop-off location. The team that assembles the most kits within 45 min will win a Fetch Manipulator Research Robot.

Competition Robot

The Robot used for the competition will be a Fetch Mobile Manipulator. The robot will have Ubuntu(™) 18.04 and ROS(™) Melodic installed. Official Competition Robots will be provided for teams to use at the competition. Teams who have access to their own Fetch Research Platform can bring their own robot as long as no hardware modifications have been made.

Competition Tasks

The competition will focus on autonomously completing combined manipulation, perception and navigation tasks. The task is to assemble a kit from four objects obtained from stations around the arena. The objects may be picked from bins and require additional processing before being placed in a kit and transported to a drop-off location. Additional processing includes operating equipment through physical manipulation or a wireless interface. The challenge includes the perception of objects in the environment, successfully avoiding any collisions while manipulating and transporting the objects.

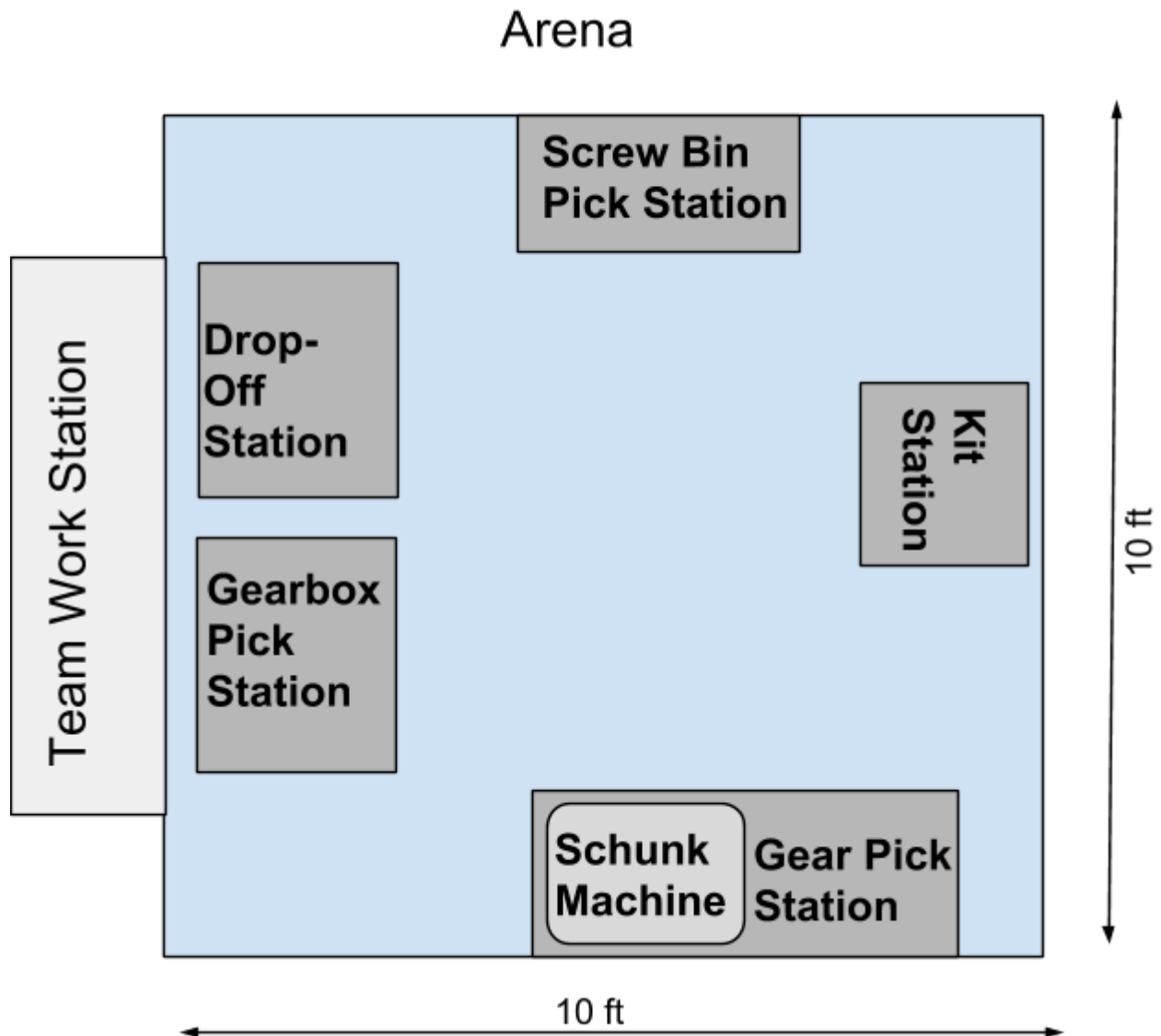
Competition Environment

The competition will take place in an arena approximately 10 feet by 10 feet in size. The arena will feature stations with the items and machinery the robot needs to complete the competition tasks. A map of the arena will be provided. The objects which will be used for manipulation will be announced and provided to teams ahead of time, and will be both detectable and manipulable with the Fetch Mobile Manipulator.

The competition environment specifics will be made available before the competition and an environment provided for Gazebo simulation.

Qualified teams will be able to schedule remote access to a real robot and environment located at Fetch Robotics.

2 Arena Setup



3 Objective & Definitions

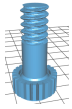
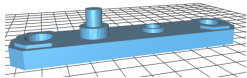
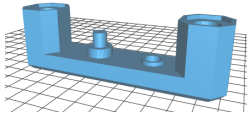
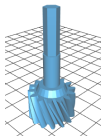
The objective is to fill as many orders (assembled kits) as possible in 45 min. The robot can start anywhere inside the arena.

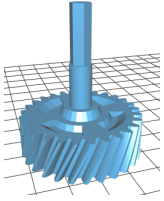
Order

An order consists of picking 6 items from their respective locations, placing them into the provided kit and placing the kit at the drop-off location.

Items

Items will be 3D printed parts of a gearbox assembly. New items for kits can be found in their default location. The items will be 3D printed parts and links to the CAD files and printer settings will be provided so that teams can create their own for training before the competition.

Item	Per Kit		Default Location
Kit	1		There will be kits at the Kit Station
Bin	0		The bin will start at the Screw Bin Pick Station
Bolt	2		Bolts will bin in the Bin
Gearbox Top	1		Gearbox Top will be at the Pick Station
Gearbox Bottom	1		Gearbox Bottom will be at the Pick Station
SCHUNK Machine	0		The SCHUNK machine will be at the Machine Station. This station simulates machining a part. A wireless interface to the machine will be used. The robot will place a part in the machine's SCHUNK Chuck and trigger it to close. The machine will only allow the part to be released after 2 minutes. The robot will take the part from the chuck and place the part in the kit. Before the machine will turn on, the safety door must be slid closed.
Small Gear	1		Small Gear will be next to the Machine, and must be machined.

Large Gear	1		Large Gear will be next to the machine, and just added to kit.
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At the start of each team's turn, there will be a number of items at each station. Once a station runs out of an item, it will be replenished.

Kit



Approximate Dimensions:
 Length: 24 cm, Width: 24 cm, Height: 13 cm
 Color will vary.

Parts must be placed into the kit in the compartments shown above. There will be a scoring penalty for parts placed in the wrong compartment of the kit (see section on Scoring).

Stations

Kit Station

The empty kits used to deliver the parts start at this station. The kits will be on a table at the station. Kits will be approximately evenly spaced and not touching. Once all kits have been taken from the station, more kits will be put at the station to replace them.

SCHUNK Machine/Gear Pick Station

This station features two types of gears on a surface. The gears will be approximately evenly spaced and not touching. The robot must place the larger gear into the SCHUNK Machine located next to the gears. The SCHUNK Machine will simulate machining the part. This process will take 2 minutes, after which the robot can retrieve the large gear from the machine and place it in the kit. In addition, the small gear must be placed into the kit. These tasks may be done in any order. If all parts of one type have been picked from this station, the parts will be replenished.

Gearbox Pick Station

At this station the top and bottom parts for the gearbox will be in bins. The parts will be approximately evenly spaced and not touching. The robot must put one of each of the top and bottom gearbox parts into each kit. If all parts of one type have been picked from this station, the parts will be replenished.

Screw Bin Pick Station

The screws will be in a bin at this station. They may be touching and not evenly spaced. The robot must put two screws into each kit. If all parts of one type have been picked from this station, the parts will be replenished.

Drop-Off Location

This is the station where kits must be dropped off. Kits may be placed anywhere on the surface at the drop-off location for simulated inspection by a SICK Lector sensor. Once a completed kit is placed at this station, the time will be recorded and used as the total delivery time in the event of a tie (see section on Scoring).

Note:

The above stations can be visited in any order and items can be placed in the kit in any order.

Time

Each team will have up to 45 min to complete as many orders as possible. Before their turn, each team will have an hour to set up in their arena. If the team is not ready to start on time, they have can have an additional 5 minutes of set up time at the expense of 1 point. This penalty is applied at the end of a total run (isn't cleared during a do-over).

During the 45 min competition, the team is allowed one do-over. Where they can restart the competition, resetting the environment and robot but not the time. This do-over will wipe penalties from dropped items and collisions (but not late start penalties).

Team Interaction

The Team is not allowed to enter the arena at all during the competition run. Additionally they are not allowed to interact with the robot via any means during the competition run.

4 Scoring

Only full kits delivered to the drop-off station will count towards the score. The panel of judges will be comprised of experienced roboticists and their decisions are final.

Action	Points
Full kit delivered (all 6 items and kit at drop-off station)	7
Dropped Item	-1
Collision with Environment (minor)	-1
Kit delivered with extra item(s)	-1 (per extra item)
Kit delivered with item in incorrect section of kit	-1 (per misplaced item)
Kit delivered with item(s) missing	0

Example: One full delivery (with no missing items) is worth 7 points. If one item was dropped during the run (assuming a replacement was then successfully placed in the kit), then the final score would be 6.

Example: Partially complete kits are worth 0 points. If a team starts by delivering 3 empty kits to final station to fill there, but when the time runs out, only one kit is complete, and no items were dropped. The final score would be 7.

Example: Misplaced items are worth -1 points and extra items are worth -1 points. These penalties can compound. A kit delivered with an extra gear in the wrong section of the kit will incur a penalty of -2 points and be worth 5 points.

Dropped parts

If a robot drops an item or the kit on the floor of the arena, the robot is expected to avoid the dropped part while navigating. Penalty for dropped parts is 1 point per item. If an full kit is dropped, this is 7 points in total (6 items and the kit). Dropped items will be cleared once the robot is a safe distance from the item (at the discretion of the judges).

Collisions with Environment

Collisions between the Robot and the Environment will result in deduction of points. Soft/Controlled Collisions between the end effector and the environment during manipulation is accepted at the judges' discretion.

If there is an uncontrolled collision with the environment that does not result in damage to the environment (at the judges' discretion) then the penalty is 1 point. If the collision results in damage to the environment (or the robot) or the robot has to be emergency stopped (at the judges' discretion) then the team must use their do-over (see Time section above) or end their run (if no do-overs are left or if damage to the robot has been made, or the judges deem the code unsafe). Any time spent repairing the robot or environment will continue to be deducted from the team's overall time slot.

Example Delivery

The robot starts at the Kit Station. The robot picks up a kit.

The robot drives to the SCHUNK Machine Station. The robot puts the large gear into the SCHUNK Machine and closes the door. The machine runs for 2 minutes. While the machine is running, the robot picks the smaller gear and places it into the kit. After the machine is finished, the robot retrieves the large gear from the machine and puts it into the kit.

The robot drives to the Gearbox Pick Station. The robot picks each of the gearbox parts individually and places them in the kit.

The robot drives to the Screw Bin Pick Station. The robot picks a screw from the bin at this station. While transferring the screw to the kit, the robot drops the screw on the floor. The robot picks two new screws from the bin one at a time and places them into the kit.

The robot drives to the Drop-Off Station avoiding the dropped screw. The robot places the completed kit at the Drop-Off location.

This is just an example, the stations can be visited in any order as long as the kit is filled. This would earn a team 6 points (7 points for a completed kit, -1 for the dropped part).

Note: The panel of judges will be comprised of experienced roboticists and all judges' decisions are final.

5 Winning

To win a Fetch Mobile Manipulator, a minimum score of 14 points is required. The team with the highest score above 14 points wins.

In the event of a tie: The team that made their deliveries in the shortest total time will win. Once a kit is complete and at the drop-off location, the time will be recorded. The time of the final kit delivered within a team's turn will be used as their total delivery time.

In addition, runner-up prizes will be SICK LiDAR sensors provided by SICK/EandM. Other additional runner up prizes may be added to the prizes list.

Prizes

First: Fetch Mobile Manipulation Research Robot

Second: MRS1000 4-layer LiDAR (1) and TiM561 LiDAR (1) provided by SICK/EandM

Third: MRS1000 4-layer LiDAR (1) and TiM561 LiDAR (1) provided by SICK/EandM

Other Prizes: TBD

6 The Robot

Hardware

The competition will use standard, unmodified Fetch Mobile Manipulators. Teams can bring their own Fetch Mobile Manipulator. A limited number of Fetch Mobile Manipulators will be made available on site for use in the competition and for limited use for testing before the competition, possibly as shared resources.

Software

Teams planning to use Fetch-provided robots should send a bash script to install source packages/debs/clone their slow-building repos at least two weeks ahead of the competition so that their slow-building software can be pre-installed on their accounts. The Fetch-provided robots will use ROS Melodic on Ubuntu 18.04.

7 Competition Dates

May 19, 2019: Staff Setup Day

Fetch Staff will be setting up the competition space. The space will not be open to teams at this time.

May 20, 2019: Team Setup Day

Teams can setup and test their entries. Teams will be able to schedule approximately 1.5 hours each to use Fetch-provided hardware in the arena. Teams with their own hardware can schedule also schedule 1.5 hours to use their hardware in the arena.

May 21, 2019: Competition Day 1

Teams will have 1 hour competition slots that start at the beginning of the hour. Teams can arrive 1 hour before their competition slot to start preparing their robot in their arena. On the hour, the team's competition turn starts. At 45 min after the hour, the competition slot ends and the team vacates. The next team's turn starts on the next hour.

May 22, 2019: Competition Day 2

This will work the same as the previous day, but if a team ends their run early, they will vacate the arena and not use the remainder of their time slot.

Example Schedule:

Schedule	Arena 1	Arena 2
9:00 am	Team 1 arrives and sets up their robot in the arena.	
10:00 am	Team 1's competition turn starts	Team 2 arrives and sets up their robot in the arena.
10:45 am	Team 1's turn ends and they vacate the arena.	
11:00 am	Team 3 arrives and sets up their robot in the arena.	Team 2's competition run starts.

If a team wants to end their run early, they can use the remainder of their time slot as they wish to practice or make changes ahead of their run on the second day.