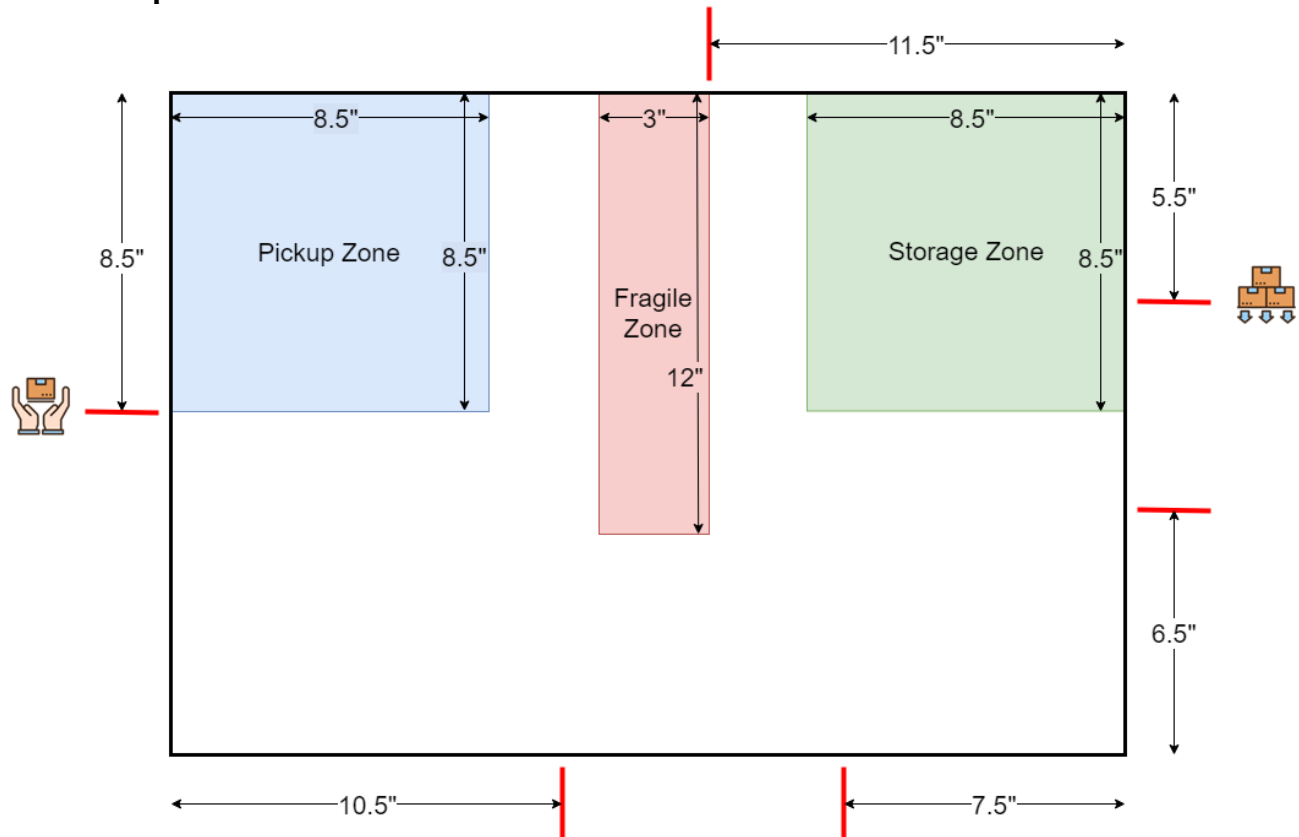


## LAB 6: WAREHOUSE AUTOMATION

Due: November 20<sup>th</sup>, 11:59pm EST

In this lab, your robot will be tasked with automating a warehouse. It will have to collect packages (cubes) from the pickup zone and deliver them to the storage zone, avoiding the fragile obstacles in the way. Your goal is to deliver as many packages as possible within 5 minutes.

### Arena Setup:



**Starting Conditions:** The robot will begin near the center of the arena with a random orientation. It will first have to localize itself, then proceed to the pickup zone. Once in the pickup zone, the robot must indicate through an audio cue that it is ready to begin delivery. From that point on, a cube will be placed within the pickup area for the robot to deliver.

**Delivery:** Once the delivery process has started (i.e. robot makes request while in pickup zone), a cube will be placed in the pickup zone. The robot must pick it up and deliver it to the storage zone, avoiding the fragile zone along the way. Once the robot leaves the storage zone, the cube will be moved back to the pickup zone. This process will be repeated until the 5 minute limit passes.

---

**Red lines** show the center placement of localization symbols. This is the same layout as we used in Lab 4. The identity of most of the localization markers remains random and unknown, except the two symbols shown in the figure corresponding to the pickup and storage zones. You can choose to use this additional information, or to continue to use the particle filter you had which will treat all localization symbols equally.

A cube will be placed in the **Pickup Zone** once the robot is ready to receive them. Only one cube will be placed at a time.

The robot may enter the **Fragile Zone** while it is localizing. Once cubes are being delivered, the robot must avoid the fragile zone completely. You can think of this as a safe zone for human workers to walk in.

The **Storage Zone** is the destination for the cube. The cube can be placed anywhere in the storage zone as long as at least 50% of the cube is inside the storage zone.

To aid the grading process, please mark the boundaries of the **Pickup Zone**, **Fragile Zone**, and **Storage Zone** in a way that is clearly visible in the video.

If you wish, you may relocalize in the middle of the delivery process. If the robot is holding a cube, it must be put back in the **Pickup Zone** prior to initiating another localization. Going into the **Fragile Zone** during any localization process does not count as a penalty.

**Notes:**

- There will be no starter code for this lab. You can reuse code from the previous labs
- You may generate your own map for path planning using the measurements provided.
- At least 50% of the cube should be inside the storage zone boundary for it to be considered as delivered correctly
- The robot will be considered to be inside the fragile zone if at least 50% of the robot is within the boundary of the zone
- There will be a 5-minute limit for each run. The timer starts when you set the robot down in the arena for localization.
- You may use any built-in Cozmo/Vector functions along with previous lab codes.
- The video should be **continuous** and fixed on the arena for the entire length. The video should be shot from overhead (bird's eye view) so that we can clearly see the position of the robot relative to the area boundaries.
- Since we're only using one cube at a time, you need to manually move the cube from the pickup zone to the storage zone after you can verify that the robot has successfully put the cube down in the storage zone, and the robot is moving back to the pickup zone.
- Delivering 4 cubes is required for full credit. If you can deliver a 5<sup>th</sup> cube, you will be awarded 8 extra points to the lab.

**Grading:** Grades will be assigned as follows (four cubes must be delivered for full credit):

Initiating delivery process	15 pts
Visible boundaries of all 3 zones	5 pts
Cube 1	20 pts
Cube 2	20 pts
Cube 3	20 pts
Cube 4	20 pts
Cube 5	8 pts
Entering Fragile Zone (each time)	-5 pts
Video link is unviewable	-10 pts

**Submission:** Zip and submit all your code and maps used on Gradescope. Be sure to enter your names in all files. One team member should submit the code to Canvas. If you relied significantly on any external resources to complete the lab, please reference these in the submission comments.

A 5-minute video usually results in a large file. Please upload your video to YouTube and post a link on Gradescope along with the code. Make sure that the link is **public** or **unlisted**. Posting a private link will result in a penalty.

**Example Run:**

	# cubes in pickup	# cubes held by robot	# cubes in storage	# total cubes in arena
Robot starts in middle	0	0	0	0
Robot moves to pickup area and signals delivery start	0	0	0	0
New cube placed in pickup area	1	0	0	1
Robot picks up cube	0	1	0	1
Robot exits pickup area and starts to move away	0	1	0	1
Robot places cube into storage	0	0	1	1
Cube placed back to pickup area	1	0	0	1
Robot returns to pickup	1	0	0	1

Robot picks up cube	0	1	0	1
Robot exits pickup area and starts to move away	0	1	0	1
Robot places cube into storage	0	0	1	1
Cube placed back to pickup area	1	0	0	1
Robot returns to pickup	1	0	0	1
Robot picks up cube	0	1	0	1
Robot exits pickup area and starts to move away	0	1	0	1
Robot places cube into storage	0	0	1	1
Cube placed back to pickup area	1	0	0	1
Robot returns to pickup	1	0	0	1
Robot picks up cube	0	1	0	1