Operations Manual

Table of Contents

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1. Before the Operation

For safety concerns, the operator should go over the following checklist before running an operation:

Pre-Op Checklist:

˅ Click to Expand

- **Check around the AGV operating area to ensure that no obstacles (fallen merchandise, bungee cords, etc…) are left on the floor.** *Aside from the QR code labels, ensure that there are no objects blocking the aisles between the pod racks.*
- **Floor Cleanliness:** If needed, use a dry mop to clean the warehouse floor. For stain removals, spray Windex and wipe with a microfiber cloth.
- **QR code floor labels inspection:** If needed, clean the QR code labels on the floor with a dry mop. Lightly mop over QR codes to remove dust. If any damaged QR codes are found, write down the QR code number and notify the manager to replace or patch a new QR code on the floor.
- **Rack(Pod) inspection:** Rack alignment. Misaligned racks in the warehouse may lead to rack collisions or scratches since the AGV with the lifted rack may move through the aisle with misaligned racks. Therefore, the operator should inspect each aisle, ensuring all racks are properly oriented.
- **Charging station inspection:**
  1. Ensure the charging station is on.
  2. No stains or dust cover the electrodes at the charging station.
 3. The path to the charging station is cleared.

- **AGV inspection:** Inspect each AGV thoroughly through the following procedure:
    1. Visual inspection: check the appearance of the AGV to see whether there are any missing bolts or parts on the AGV. Notify the warehouse manager if a problematic AGV is found.
    2. Rack(pod) QR code reader inspection: Ensure the robot's top-side QR code reader is well-connected and is not damaged. If needed, blow the dust out of the reader so that the QR code reader can read the rack(pod) ID clearly during the operation.
    3. Obstacle avoidance sensor inspection: Ensure there is no dust block the obstacle avoidance sensor on the AGV. A dusty obstacle avoidance sensor can interfere with the AGV operation.

Obstacle Avoidance Sensor

4. **Two red emergency stop buttons are released**. Confirm the two red emergency stop buttons are released firmly by twisting both red emergency stop buttons clockwise. After twisting the button clockwise, the operator should notice the button level difference if the button has been pressed before.

Emergency Buttons
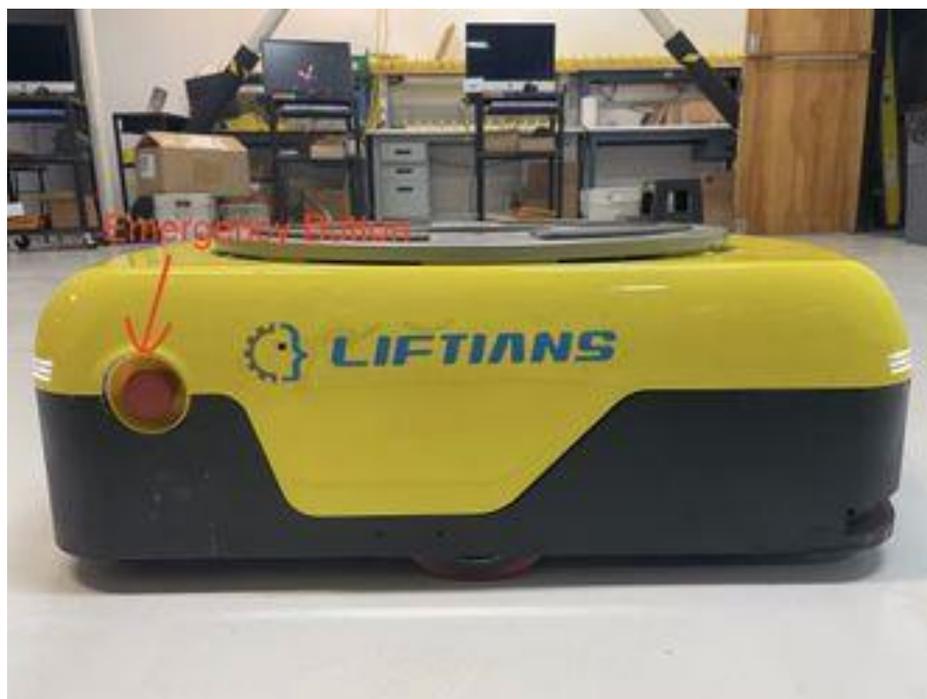
5. Turn on the AGV. When an AGV is on, its headlights and taillights should turn solid white if aligned with the QR code on the floor. If the AGV blinks red lights after turning on, the operator should adjust the AGV in alignment with the QR code on the floor and reboot the AGV after the adjustment. To determine the current AGV status, please refer to the following table.
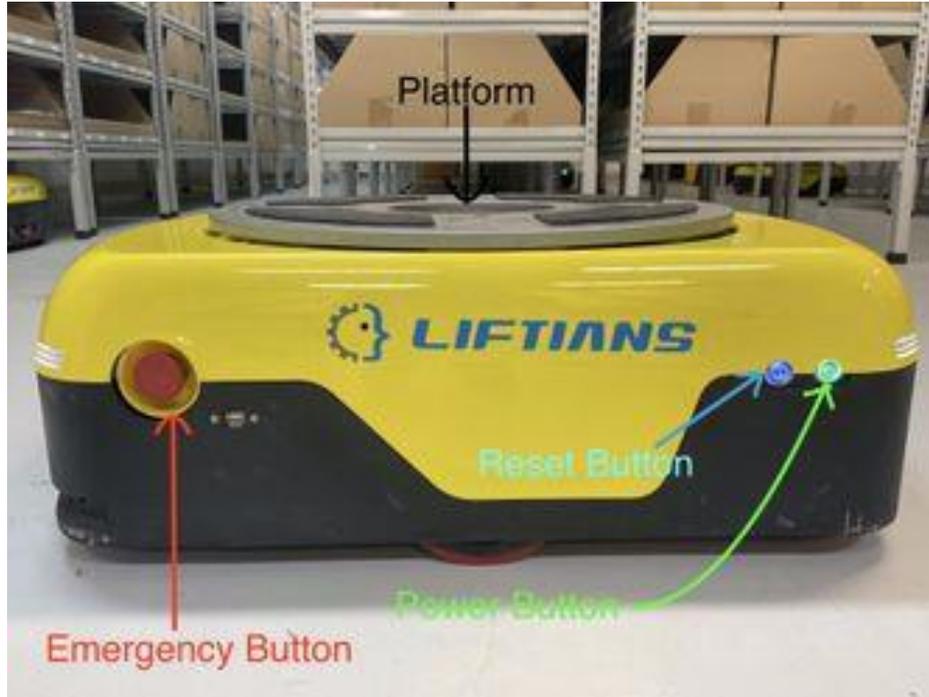
2. AGV Light Key

Lights on the AGV	AGV status description
Headlights and tail lights are **off**; the reset and power buttons are **on.**	The AGV is in the sleep(power-saving) mode because of not receiving new commands for over 5 minutes. If a new command is assigned to the AGV, headlights and taillights will turn into white color.
Headlights and tail lights are **solid white**.	The AGV is idle, ready to receive new commands.
Headlights are **solid blue**, and tail lights are **off**.	The AGV is moving forward.
Headlights are **off**, and tail lights are **solid red**.	The AGV is moving backward.

The right headlight and right tail light are **solid yellow**.	The AGV is turning rightward.
The left headlight and left tail light are **solid yellow**.	The AGV is turning leftward.
Headlights are **solid yellow**, and tail lights are **off.**	The AGV obstacle detection sensor has detected an obstacle in front of the AGV during its mission. Thus, the AGV halts for an obstacle in its path.
Headlights are **solid green**, and tail lights are **off.**	The AGV is charging at the charging station.
Headlights are **solid orange**, and tail lights are **off.**	The AGV is lifting or pulling down its platform.
Headlights are **solid red**, and tail lights are **off**.	An error occurs in the AGV. It can be caused by: (1) The AGV is not located on the floor QR code. (2) The AGV rack(pod) QR code reader cannot find the assigned rack(pod) number at its current position.
Headlights and tail lights are **solid red**.	Failure to initialize the AGV.
Headlights and tail lights are **solid purple**, **blue or dark yellow.**	The AGV is at upgrade status. An operator should not see the status in normal operation. The status can only be seen from technical maintenance.
Headlights and tail lights are **flashing green.**	At least one of the emergency stop buttons are pressed on the AGV, and it is located on the floor QR code.
Headlights and tail lights are **flashing red.**	At least one of the emergency stop buttons are pressed on the AGV, and it is NOT located on the floor QR code. To get the AGV back on track, the operator should align the AGV to the nearest floor QR code with their hands.

3. Before the Operation: Continued

Verify the connection between an AGV and the Botservice system before running an operation.

Software Inspection Procedure:

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- **Confirm that the Botservice system has identified all powered-on AGV's in the field before running an operation.**
    1. Confirm that all AGVs are idle - headlights and taillights are **solid white**. An operator should turn on the MapMonitor software to check if all AGVs are physically located at the coordinates displayed from the MapMonitor. Also, examine each AGV status on the MapMonitor software. If any AGV on the MapMonitor is found with an Error code, please try to reboot the AGV first hand. An operator is responsible for reporting the error status to the warehouse manager if the AGV on the MapMonitor still displays an error status after rebooting the AGV.
    2. Determine the current Botservice maintenance status: The Botservice maintenance status is shown on the MapMonitor's bottom tab. An operator is responsible for verifying the current Botservice maintenance status before an operation.
        1. Maintenance: **false** - The Botservice system is in operation mode. It is ready to accept new orders from WMS requests.
        2. Maintenance: **true** - The Botservice system is in maintenance mode. New orders requested from WMS will be rejected. A user logging into MapMonitor will trigger the maintenance mode. Typically, only the warehouse manager or a trained operator is authorized to log into maintenance mode. Maintenance mode is needed for the following conditions:
            1. A new rack(pod) is placed in the warehouse. Scanning the new rack(pod) through a QR code reader from an AGV is required so that the Botservice system can synchronize the current rack(pod) ID number and its coordinates in the map and the Botservice database.
            2. Re-arranging the rack(pod) position in the warehouse. In the maintenance mode, the warehouse manager can use the Mapmonitor to assign an AGV to move the rack(pod) to the desired location. Moreover, swapping rack(pod) location for production need.
            3. Scheduled construction projects in the warehouse. Some of the racks may need to place at temporary non-storage area locations due to the scheduled construction project.
            4. System error recovery during an operation. Power outages, network errors, and malfunction AGV removals are required to initiate a maintenance mode to recover the system. See "Troubleshooting during the operation" for more details.

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4. During the Operation & Troubleshooting Scenarios

Operators and the manager **MUST** follow these safety guidelines once the operation is initiated:

- Stepping into the operating area is strictly forbidden unless the AGV recovery procedure is needed. In other words, the operating area - floors with QR codes - is restrictive to AGV activities only, with the exception of an AGV error needing human evaluation.
- Keep a 6-inch clearance between stations and stools. Typically, operators place a stool in front of a station to pick up items on the higher layer pod. However, placing a stool too close to the station can interfere with the AGV moving the rack(pod) into the station since the AGV may identify the stool as an obstacle on its path.
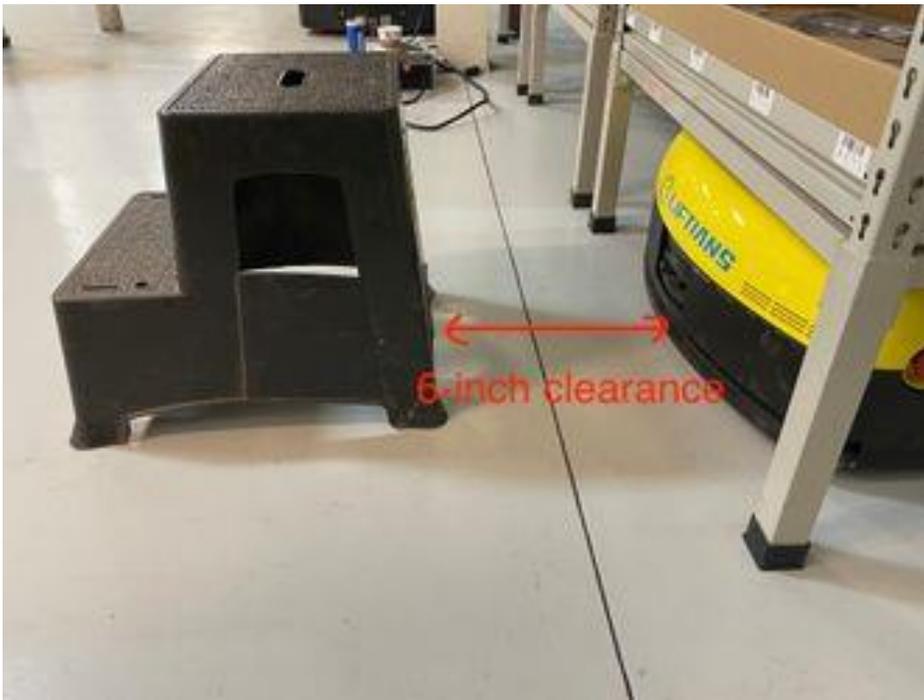
- Tighten bungee cords to the rack after picking and fulfilling items to secure items from slipping out of the bin box.

Troubleshooting Scenarios (during operation)

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- **Orders have been assigned from the WMS to the APIServer, but AGVs do not deliver racks to stations:** Check the response APIServer message to get more troubleshooting.
- **Some of the AGVs halted at their current location:** Check the AGVs connection status. If the AGV shows offline status, find out its location from MapMonitor and reboot it. Typically, rebooting the AGV helps with the AGV re-connection to the service.
- **An AGV has delivered the rack(pod) to the station. However, the pod was not pulled down at the station. And the AGV kept spinning, blinking red light and green light sporadically:** The AGV is trying to align its position with the station QR code. AGV should pull down the pod eventually. If the case frequently happens at the same station, consider replacing the station QR code with a new one or calibrating the station QR code.
- **An AGV is under the assigned rack, and red lights are on:** The AGV is trying to identify the rack(Pod) ID number but fails. Adjust the rack lightly with hands; then, the AGV lights should turn into green lights and lift the pod.
- **AGV recovery process:**
    1. Press one of the emergency buttons on the AGV, ensuring that the AGV lights are blinking
    2. Adjust the AGV position to a floor QR code until it flashes green lights. Put the pod back to the AGV platform if the AGV current mission is carrying a pod.
    3. Release both red emergency buttons. In other words, hold and twist the button clockwise.

4. Reboot the AGV by pressing the green button two times. Then the AGV should work on its remaining mission. If the AGV lights keep blinking after the reboot, please confirm that both red emergency buttons are released and press the reset button to reset the AGV.
- **The moving pod scratches the other pods, leading to the AGV running out of track:**
  1. Immediately pause the system operation through MapMonitor.
  2. Find out the AGV and press the red emergency button.
  3. Adjust the adjacent pods to ensure that their orientation is correct.
  4. Follow by the aforementioned AGV recovery process to recover the AGV.
  5. Press the resume tab on the Mapmonitor to start the operation again.
- **Power outages or Network out of order:** The whole system must be **RESET** - Botservice, APIServer, WMS front-end, and AGVs.
  1. Once the power and network are recovered, turn off the APIServer and Botservice.
  2. Clear the "RobotTask" and "PodRecord" table in APIServer.
  3. Restart the Botservice.
  4. Recover AGVs with "AGV recovery process".
  5. In Botservice maintenance mode, use the scan feature to synchronize the pods not located in the storage area.
  6. Identify pod real-world location is the same as its location on Mapmonitor. If not, use the scan feature to sync the pod location in MapMonitor.
  7. Use the MapMapmonitor to return pods back to the storage area, including the pods at the stations.
  8. Restart the Botservice again.
  9. Verify pod real-world location is the same as its location on Mapmonitor. In other words, operators must check each pod location in the warehouse storage area is the same as the one on Mapmonitor.
  10. Switch the Botservice to the operation mode. In other words, "IsMaintenance: false "
  11. Restart the API server.
  12. Re-send orders from WMS. The system should be able to accept new orders now.

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5. After the Operation

- It is recommended to clean the warehouse floor with a dry mop once a week.
- If the system will not be operated for three plus days, Turn off AGVs.
- Visual inspection to AGVs: Inspect the AGV to see if there is any damage.

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6. MapMonitor