

CLAIMS

What is claimed is:

1. A method for autonomously docking an autonomous vehicle, the method comprising:

receiving data comprising (i) an indication that the autonomous vehicle is within a docking location and (ii) an adjustment distance to place the autonomous vehicle within a threshold distance of the docking location;

identifying, using an external reference point detection module, an external reference point to the autonomous vehicle; and

incrementally adjusting, using a docking module, a position of the autonomous vehicle in a first axis based on a distance between the autonomous vehicle and the external reference point until either (i) the autonomous vehicle is within the threshold distance of the docking location or (ii) a number of adjustments exceeds an adjustment maximum.

2. The method of claim 1, wherein the threshold distance is less than 5 centimeters of a boundary in the first axis of the docking location.

3. The method of claim 1 or claim 2, wherein the data further comprises a plurality of light and detection ranging (LiDAR) data points.

4. The method of claim 3, wherein the external reference point is identified using the external reference point detection module by: identifying a subset of the plurality of LiDAR data points located within a designated region; determining whether the subset is greater than a threshold value; based on the subset being greater than the threshold value, generating a plurality of clusters among the subset based on distances between each LiDAR data point; for each cluster of the plurality of clusters, determining a distance to an internal reference point on the autonomous vehicle; and

identifying a cluster of the plurality of clusters having a shortest distance in the first axis to the internal reference point.

5. The method of claim 4, wherein the cluster is identified having the shortest distance in the first axis and a shortest distance to the internal reference point in a second axis.

6. The method of any of the preceding claims, wherein the external reference point has a light reflectivity that is of higher intensity than nearby surroundings of the external reference point.

7. The method of any of the preceding claims, the position is incrementally adjusted through an iterative series of applying and releasing a braking mechanism of the autonomous vehicle.

8. The method of any of the preceding claims, wherein the position is incrementally adjusted by:

determining a brake release time; releasing a braking mechanism for a portion of the brake release time;

evaluating a total amount of time the braking mechanism has been released;

determining, after the releasing and the evaluating, if the total amount of time is less than the portion of time, whether a distance the autonomous vehicle has moved is within the threshold distance, wherein the distance is compared with an absolute value of a difference between the distance and the adjustment distance; and

repeating the releasing, the evaluating, and the determining if the distance is not within the threshold distance.

9. The method of claim 8, wherein the position is further incrementally adjusted by:

applying the braking mechanism, if the total amount of time is not less than the portion of time, for another portion of the brake release time; and

repeating the determining until (i) the distance is within the threshold distance or (ii) the number of incremental adjustments exceeds five adjustments.

10. The method of any of the preceding claims, wherein the autonomous vehicle is an autonomous prime mover and the data is received from an automatic rail mounted gantry.

11. The method of any of the preceding claims, wherein when the autonomous vehicle is within the threshold distance a container is automatically loaded or unloaded onto the autonomous vehicle without manual intervention.

12. The method of any of the preceding claims, wherein when the number of adjustments exceeds the adjustment maximum, an alarm is triggered to facilitate human-aided manual loading or unloading of a container onto the autonomous vehicle.

13. A system comprising:

at least one data processor; and

memory storing instructions, which when executed by at least one data processor, result in operations for implementing operations comprising:

receiving data comprising (i) an indication that the autonomous vehicle is within a docking location and (ii) an adjustment distance to place the autonomous vehicle within a threshold distance of the docking location;

identifying, using an external reference point detection module, an external reference point to the autonomous vehicle; and

incrementally adjusting, using a docking module, a position of the autonomous vehicle in a first axis based on a distance between the autonomous vehicle and the external reference point until either (i) the autonomous vehicle is within the threshold distance of the docking location or (ii) a number of adjustments exceeds an adjustment maximum.

14. The system of claim 13, wherein the threshold distance is less than 5 centimeters of a boundary in the first axis of the docking location.

15. The system of claim 13 or claim 14, wherein the data further comprises a plurality of light and detection ranging (LiDAR) data points and wherein the external reference point is identified using the external reference point detection module by:

identifying a subset of the plurality of LiDAR data points located within a designated region;
determining whether the subset is greater than a threshold value;

based on the subset being greater than the threshold value, generating a plurality of clusters among the subset based on distances between each LiDAR data point;

for each cluster of the plurality of clusters, determining a distance to an internal reference point on the autonomous vehicle; and

identifying a cluster of the plurality of clusters having a shortest distance in the first axis to the internal reference point, wherein the cluster is identified having the shortest distance in the first axis and a shortest distance to the internal reference point in a second axis.

16. The system of any of claim 13 to claim 15, wherein the external reference point has a light reflectivity that is of higher intensity than nearby surroundings of the external reference point.

17. The system of any of claim 13 to claim 16, the position is incrementally adjusted through an iterative series of applying and releasing a braking mechanism of the autonomous vehicle by:

determining a brake release time; releasing a braking mechanism for a portion of the brake release time;

evaluating a total amount of time the braking mechanism has been released;

determining, after the releasing and the evaluating, if the total amount of time is less than the portion of time, whether a distance the autonomous vehicle has moved is within the threshold distance, wherein the distance is compared with an absolute value of a difference between the distance and the adjustment distance;

repeating the releasing, the evaluating, and the determining if the distance is not within the threshold distance; applying the braking mechanism, if the total amount of time is not less than the portion of time, for another portion of the brake release time; and

repeating the determining until (i) the distance is within the threshold distance or (ii) the number of incremental adjustments exceeds five adjustments.

18. The system of any of claim 13 to claim 17, wherein the autonomous vehicle is an autonomous prime mover and the data is received from an automatic rail mounted gantry.

19. The system of any of claim 13 to claim 18, wherein when the autonomous vehicle is within the threshold distance a container is automatically loaded or unloaded onto the autonomous vehicle without manual intervention and wherein when the number of adjustments exceeds the adjustment

maximum, an alarm is triggered to facilitate human-aided manual loading or unloading of a container onto the autonomous vehicle.

20. A non-transitory computer program product storing instructions which, when executed by at least one data processor forming part of at least one computing device, implement operations comprising:

receiving data comprising (i) an indication that the autonomous vehicle is within a docking location and (ii) an adjustment distance to place the autonomous vehicle within a threshold distance of the docking location;

identifying, using an external reference point detection module, an external reference point to the autonomous vehicle; and

incrementally adjusting, using a docking module, a position of the autonomous vehicle in a first axis based on a distance between the autonomous vehicle and the external reference point until either (i) the autonomous vehicle is within the threshold distance of the docking location or (ii) a number of adjustments exceeds an adjustment maximum.