RBE549 – Motion Planning

Assignment: **Valet**

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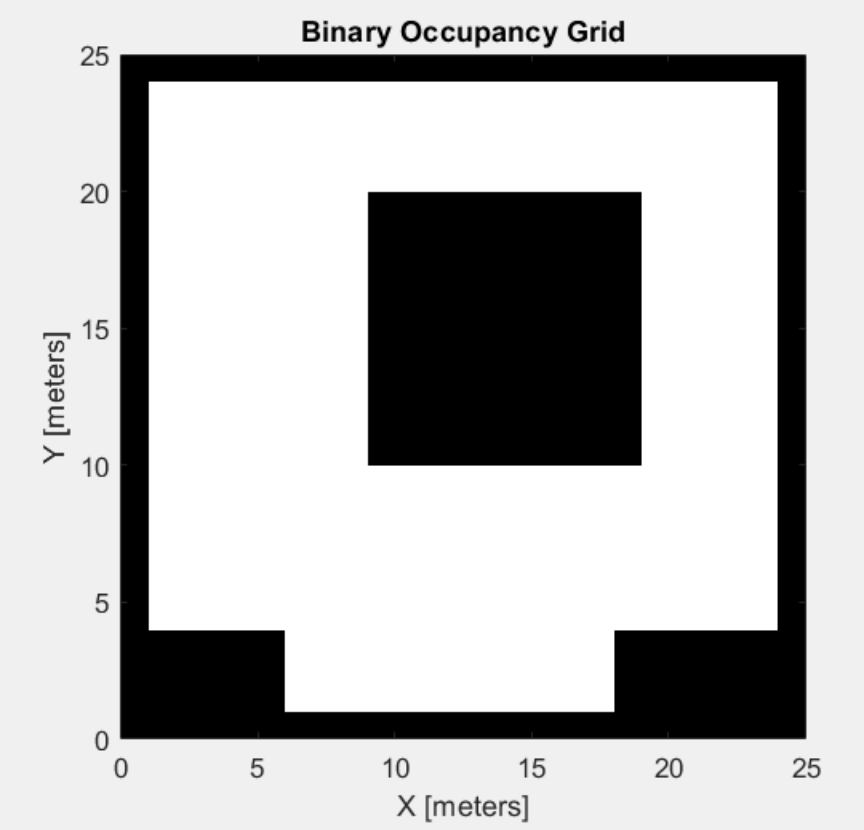
➢ Algorithm Workflow Overview (Pseudocode):

The following steps were considered for the overall workflow for finding the Kinematically feasible path for different vehicles through the Parking lot.

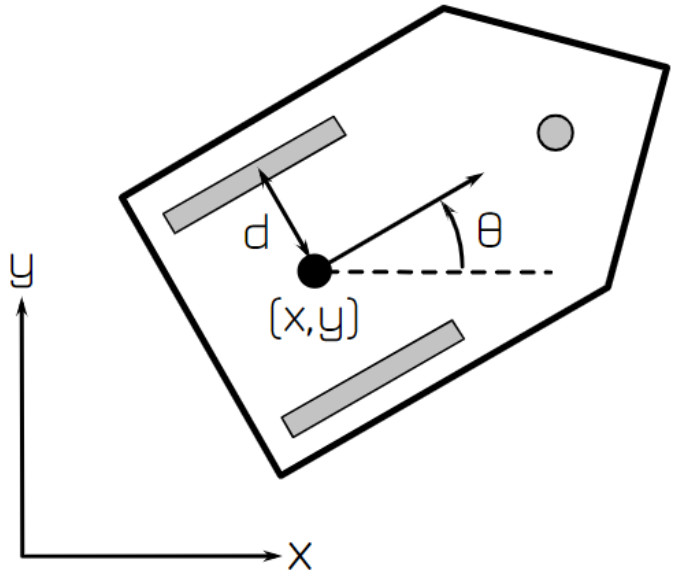
1. Setup the environment to act as a base for the planning process
2. **Inflate** the obstacle portion of the Environment to account for the size of different vehicles and avoid collision – **Minkowski sum**
3. Apply path planner on the resultant occupancy grid to get the idea path to follow (without considering the kinematics of vehicle)
4. Feed in the kinematic model of the vehicles
5. Employ a **Pure Pursuit** controller and run it on the generated path taking into account the Kinematics of vehicle
6. The result of the Pure Pursuit step will be the final Kinematically feasible path for the vehicle to follow
7. Make an iterative function to plot the final path and orientation for the robot to follow

➢ Environment Setup:

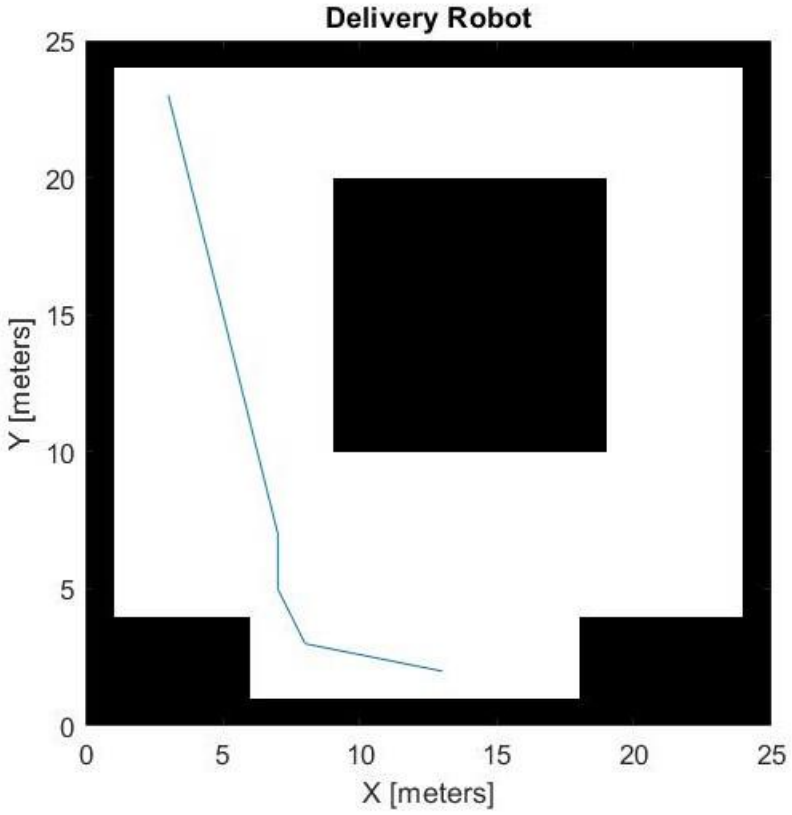
The environment was setup in MATLAB by manually forming a 25-by-25 matrix and displaying out its Binary Occupancy Map as shown in the following image.



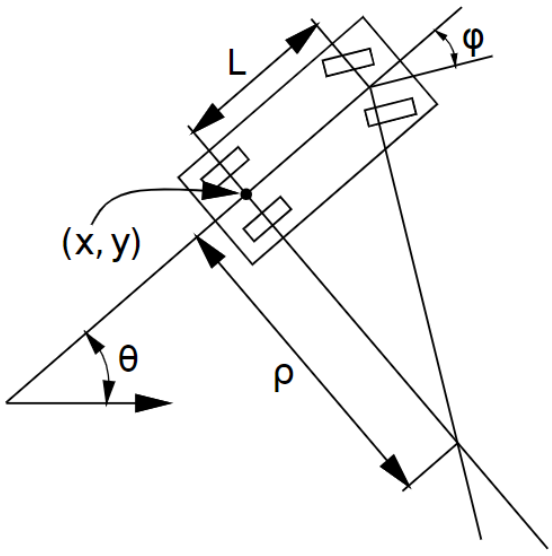
- **Delivery Robot:**



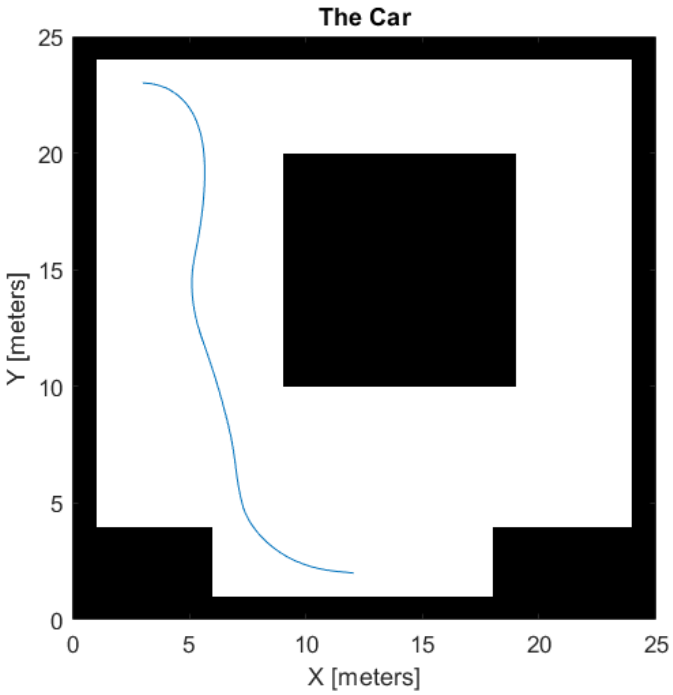
The mentioned Delivery Robot will have the Kinematics of a Differential Drive robot. The same was coded and the resultant path for the input was obtained as shown in the following image.



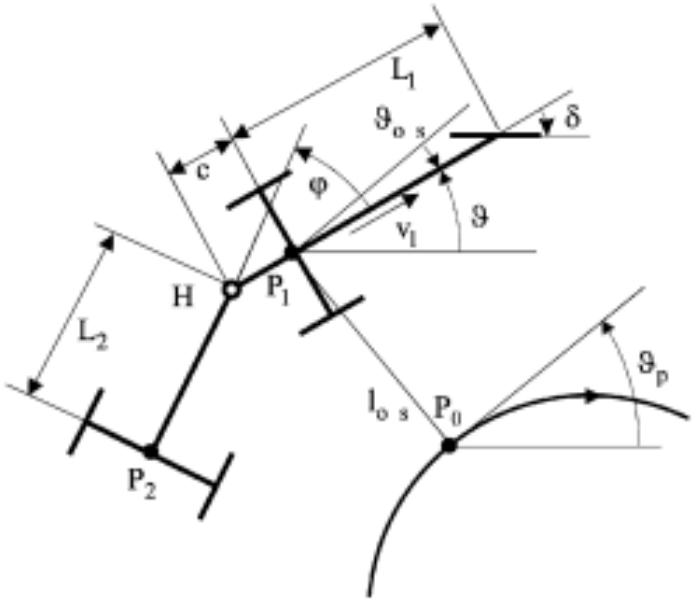
- **The Car:**



The mentioned model of Car will have the Kinematics of Ackerman Steering. The same was coded and the resultant path for the input was obtained as shown in the following image. The wheelbase was taken into account while making the STL file (as seen in separately submitted video).

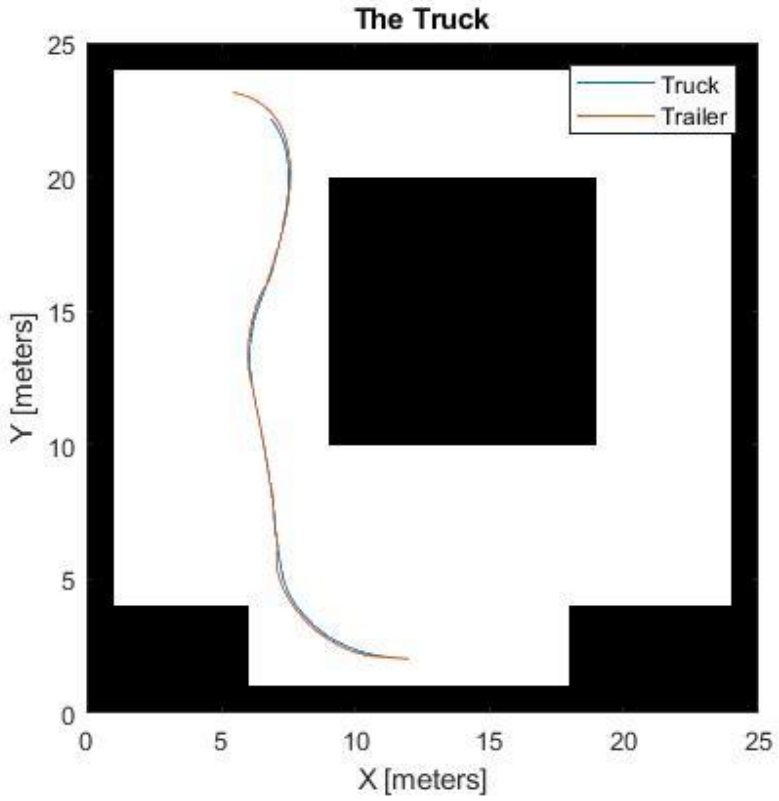


➢ The Truck:



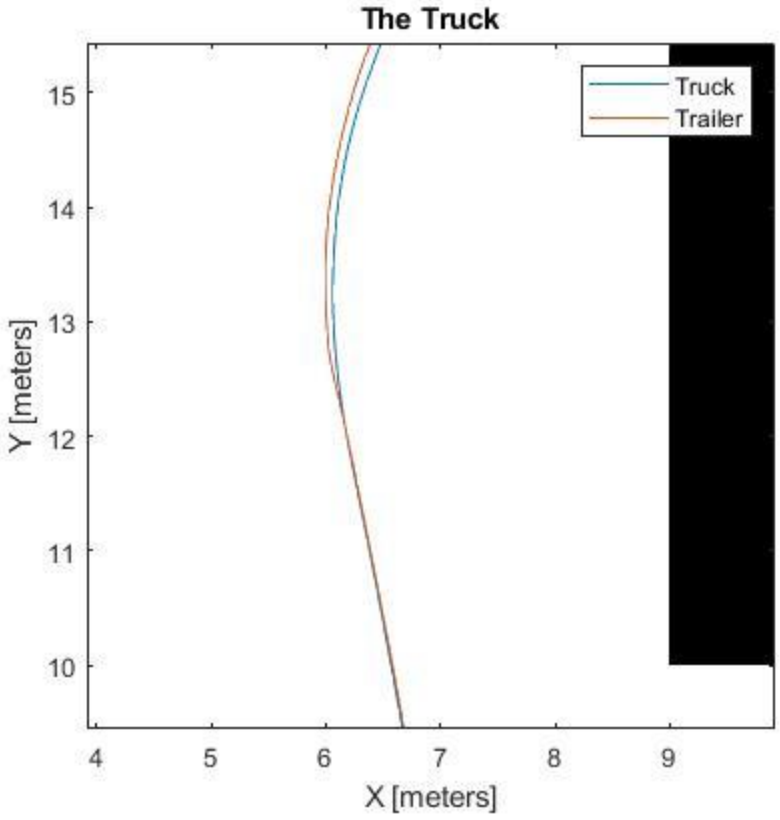
[1]

The given model of Truck is basically an Ackerman steered vehicle followed by a Differentially driven trailer. Thus, the resultant mechanism will have the Kinematics similar to the addition of Ackerman Steering and Differential drive. The same was coded and the resultant path for the input was obtained as shown in the following image.



The leading vehicle follows the Kinematic model same as the Car. For the following trailer, it is considered that the front of trailer will coincide with the center of the rear axle of the truck. The coordinates of the center of the rear axle of the trailer can then be found by simple trigonometric calculations taking into account the last pose of the trailer in terms of its orientation.

One observation was that during sharper curves, the trailer follows a considerably different path than the truck. It converges back with the path followed by truck as straighter path is approached. The same can been seen in the following zoomed image.



➢ References:

1. Astolfi, Alessandro, Paolo Bolzern, and Arturo Locatelli. "Path-tracking of a tractor-trailer vehicle along rectilinear and circular paths: A Lyapunov-based approach." IEEE transactions on robotics and automation 20.1 (2004): 154-160.
2. [Online] Simulate Different Kinematic Models for Mobile Robots - https://www.mathworks.com/help/robotics/ug/simulate-different-kinematic-models-for-mobile-robots.html
3. [Online] differentialDriveKinematics - https://www.mathworks.com/help/robotics/ref/differentialdrivekinematics.html