Arduino Project (Spring 2023)

*** To be demonstrated on 03/23/2023 (Location and time TBA) ****

Problem statement: This project is based on autonomous parking scenario. In a garage of parked cars and two-wheelers, there is a need for an autonomous parking system that can look for parking spaces by checking the lanes until an empty parking space is found. You're tasked with the responsibility of designing a robot that will be able to perform a set of tasks to accomplish these goals.

Describing the scenario

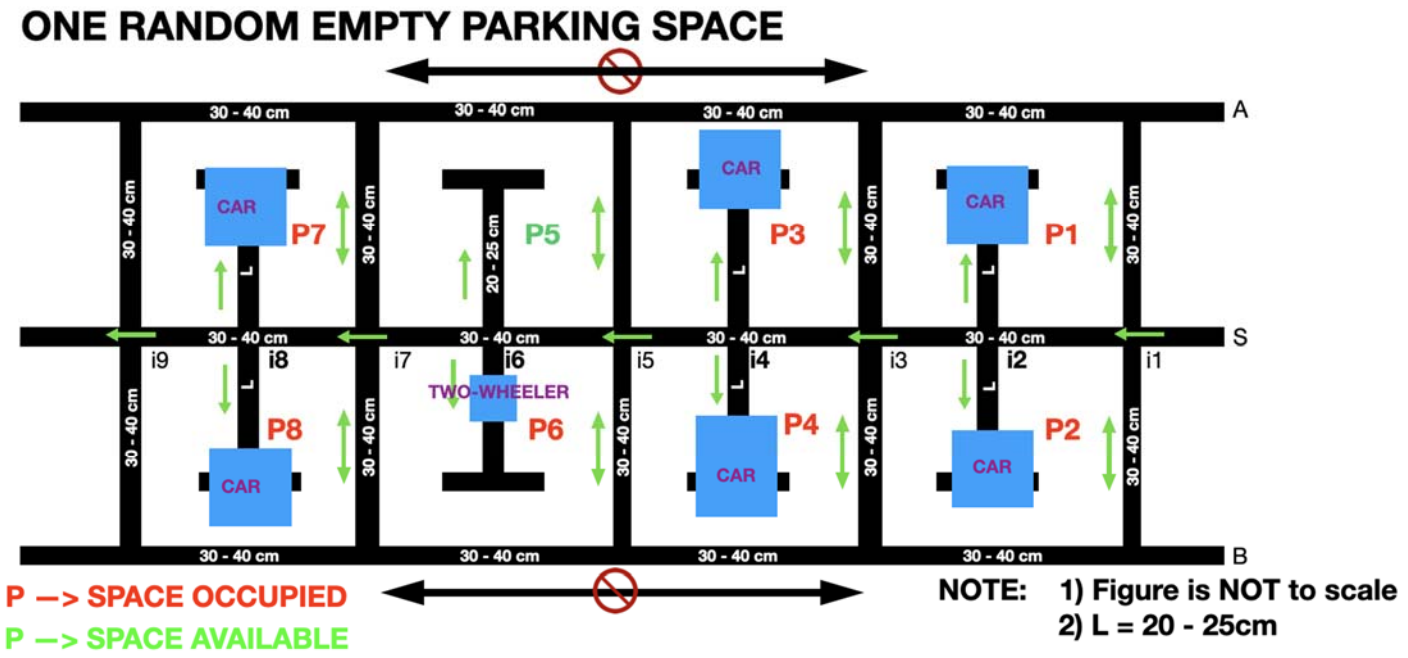

Figure 1: The map of the Parking lot

- The black tape represents the path in the parking lot. The width of the tape will be **1.8 - 2.6 cm**.
- The robot starts at the position marked 'S', which is located on the center lane.
- The **center lane (horizontal) is one way**, strictly restricted to only turns (left/right) and forward movement. There is **no movement allowed along the extreme horizontal lanes (A and B).**
- There are a total of 9 intersections labeled i1, …, i9 on the center lane.
- There are a total of **8 parking spaces** denoted by: P1, …, P8 in between the lanes, where the robot is allowed to park if a space is empty. The occupied parking spaces might have a car (object with more width) or a two-wheeler (object with less width) present.
- ONLY green colored arrows represent the directions allowed to move.
- U-turns are only allowed in bi directional lanes.
- At each intersection, the robot has the option to turn. In the **odd intersections**, labeled i1, i3, …., i9, the robot has the option to turn and move in the bi-directional lanes to **check** if the parking space is empty or occupied.

- On the **even intersections**, the robot is allowed to turn only for **parking**, if the space is empty.
- All the lengths will be as indicated on the given map.
- The **width** of the large objects (**cars**) ranges from **12-23 cm**, and the width of the small objects (**two-wheelers**) ranges from **3-6 cm**.
- The **height** of the objects (both cars and two-wheelers) ranges from **12- 30 cm**.

Task descriptions

- You will be directed to place your robot at home location S.
- Your robot must always follow the path (black tape).
- The robot is constrained to use **only one ultrasonic sensor (ping)**, which should also be fixed on the robot (the **ultrasonic sensor** can't be mounted on an additional servo or any mechanism to provide additional degree of freedom, i.e., it **should not be able to rotate**).
- As the robot starts from the home position, it must **detect intersections** (both odd and even) and provide an **indication** of their detection by some means (e.g., LED, piezoelectric buzzer, LCD display, etc.).
- At the odd intersections the robot is allowed to turn in the two-way vertical lanes and **check if the parking spaces are occupied** or empty.
- Upon detecting the objects (car or two-wheeler), the robot must provide an **indication of the object detection** by some means (e.g., LED, piezoelectric buzzer, LCD display, etc.) indicating that the parking space is occupied.
- The robot **should park at the first available parking space** (at the T-intersection) and provide an **indication of parking** (e.g., LED, piezoelectric buzzer, LCD display, etc.)
- After parking, t**he number of occupied parking spaces encountered along the route must be displayed** (e.g., LEDs, 7-segment LED, LCD display, etc.)
- Some possible cases of parking space availability are shown in Figure 2.

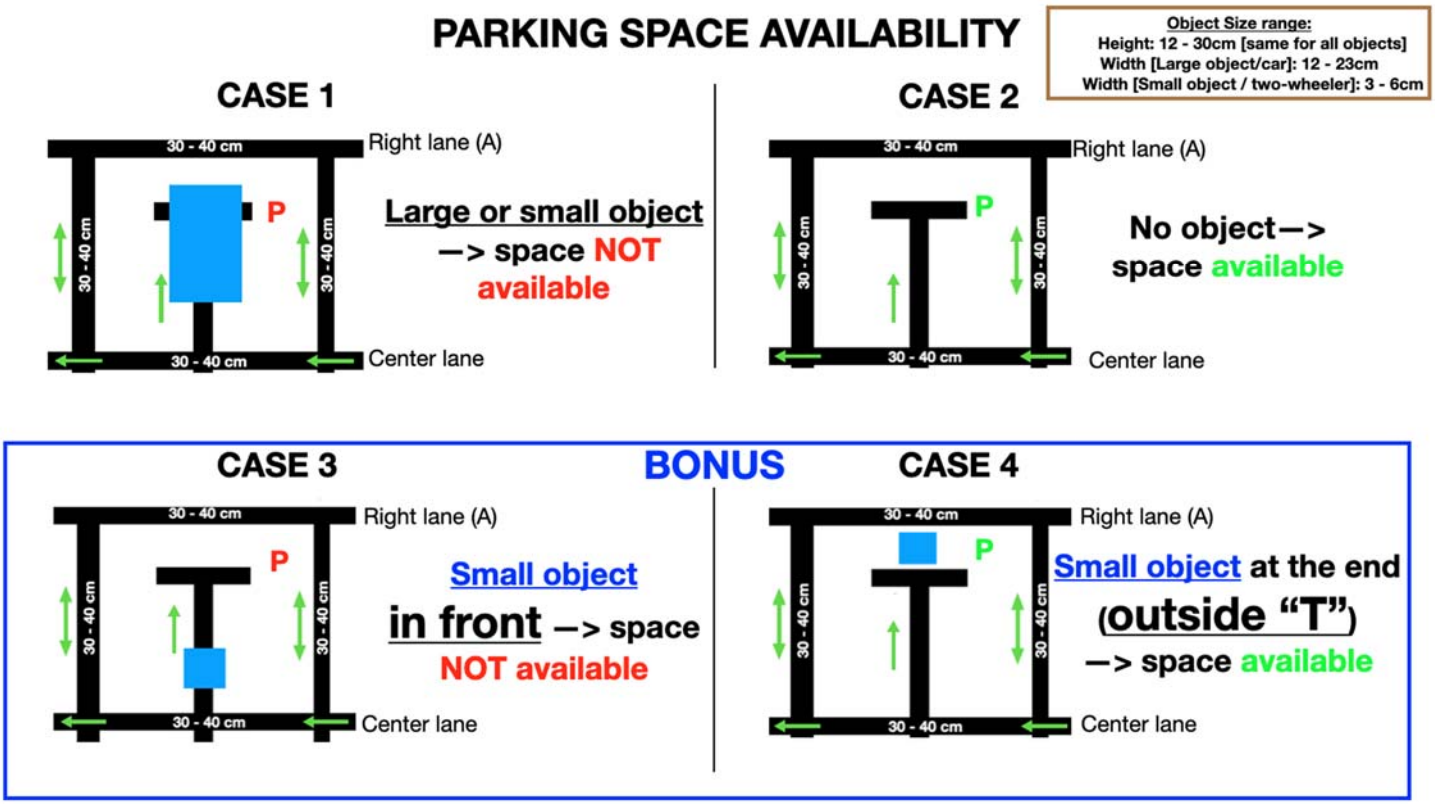

Figure 2: Parking space availability

- Case 1: an **object occupying the parking space** implying that the robot **should not park** in this case. Note that the object can be either **large** (car) **or small** (two-wheeler). As long as the lane is occupied and the object is in the 'T' zone, the parking space is occupied.
- Case 2: **no object**, i.e., the parking space is empty so that the **robot can park**.
- Case 3 [Bonus]: a **small object** (two-wheeler) occupying the parking space (in the **front** of the parking lane, **close to the center lane**) implying that the robot **should not park** in this case. A indication must be provided indicating that the space is occupied by a two-wheeler.
- Case 4 [Bonus]: a bonus scenario where the **small object (two wheeler)** is at the **end** of the parking lane (**outside of the T intersection**), so there is enough space for the robot to park, even though a two-wheeler is detected. Therefore, the robot should **detect and indicate an object** but **it should park** too.

Deliverables and Grading (Total: 100 points, extra credit: 20 points)

1. Line following robot, able to follow accurately the center lane and vertical lanes → **+ 20 points**
2. Ability to indicate intersections being traversed → **+ 20 points ('-3' for each missed intersection indication)**
3. Ability to detect and indicate when there are objects (size invariant) → **+ 20 points ('-3' for each missed object indication)**
4. Ability to park successfully at the available parking space → **+ 20 points**

5. Ability to display the number of occupied spaces encountered before parking → + **20 points ('-3' for each occupied space missed)**
6. Extra credit for bonus scenario (10 points for indicating a space occupied by a two-wheeler and 10 points for parking in front of a two-wheeler) → +**20 points**

Note: Item 5 for bonus scenario – the number to be displayed is the number of occupied parking spaces checked before parking, NOT the number of vehicles detected. These may NOT be the same in the bonus scenario.

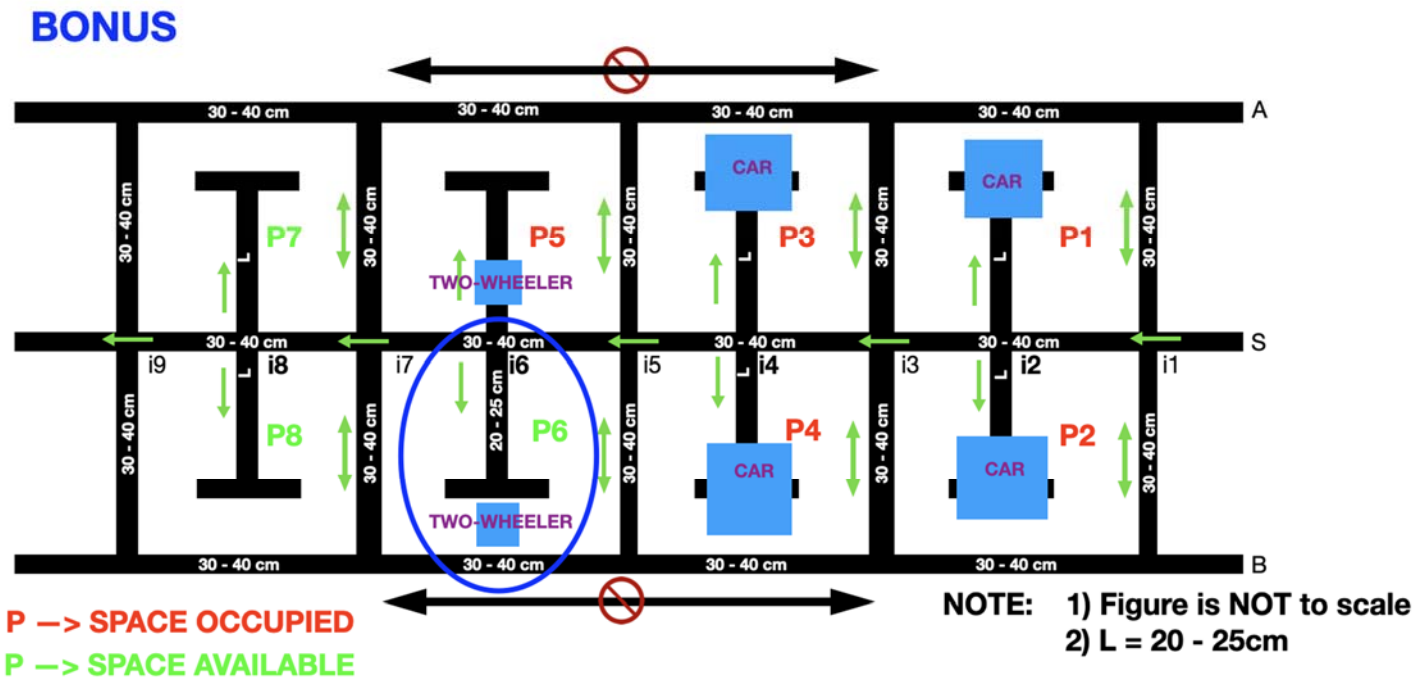

Figure 3: Bonus-scenario example

Note

- IR remote control allowed only for correcting the robot orientation when turning (Max points = 70% of the points for corresponding tasks)
- Autonomous control preferred (100% of the points)

For any questions, please feel free to reach to out the TA's:

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TA's office hours: Friday's 4-5 pm
Zoom link: https://nyu.zoom.us/j/93389225439

You may want to consider acquiring the following sensor array for line follower:
https://www.pololu.com/product/961
https://www.pololu.com/product/4246