深 圳 大 学 实 验 报 告

课程名称：机器人学导论

实验项目名称：**Wheeled Mobile Robots and Navigation**

学院：电子与信息工程学院

专业：电子信息工程

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班级：**04**

实验时间：**2024 年 10 月 8 日**

实验报告提交时间：**2024 年 10 月 14 日**

教务处制

Aim of Experiment:

1. Learn the Car-Like Vehicle and use it to take some tasks.
2. Learn the reactive navigation with example of Braitenberg vehicles.
3. Learn the Breadth-First Search and Uniform Cost Search used for the graph-based navigation.

Experiment Content:

1. Simulate Car-Like Vehicle using the Simulink model and take some tasks, such as Drive to a Point, Drive along a line.
2. Simulate the Braitenberg vehicles with MATLAB and analyze the results.
3. Understand the principle of Breadth-First Search and Uniform Cost Search and write a pseudocode of UCS.

Experiment Process：

Car-Like Vehicle:

1. Start the Simulink Model ***sl_lanechange*** and plot the result got from the simulation.
2. Start the Simulink Model ***sl_drivepoint,*** input the initial and final point, run the simulation and plot the trace of vehicle.
3. tart the Simulink Model ***sl_driveline***, input the position of line and the initial point, run the simulation.

Braitenberg vehicles:

1. Open MATLAB and input ***sl_braitenberg*** in the command line to start the Simulink model of Braitenberg vehicles.
2. Understand the function of sensor blocks.
3. Input ***sim("sl_braitenberg");*** to run this simulation.

Planning with a Graph-Based Map:

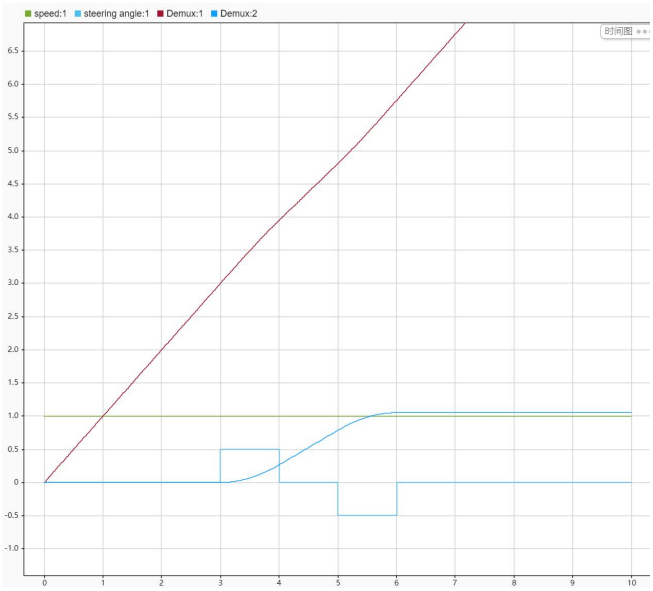
1. Import datafile and create UGraph object.
2. Plot the results from the function g.path_BFS.

3. Learn the principle of UCS for the Minimum Cost we want.
4. Use the function g.path_UCS to compute the minimum cost.
5. Plot the graph of UCS.

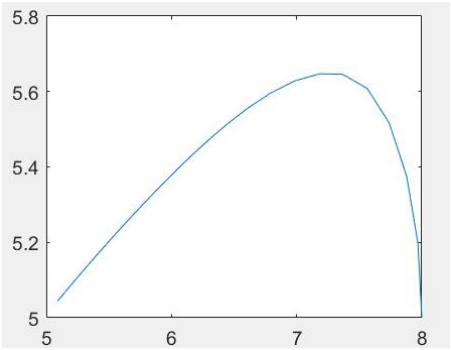
Data Logging and Processing:

(1) Car-Like Vehicle:

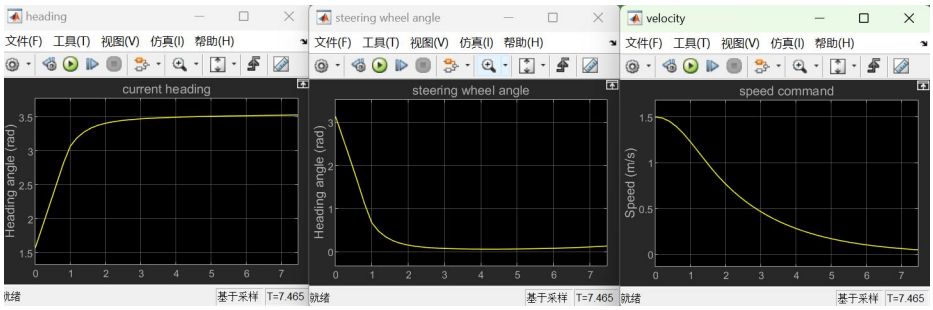
a) The curves of speed, steering angle, X, Y:



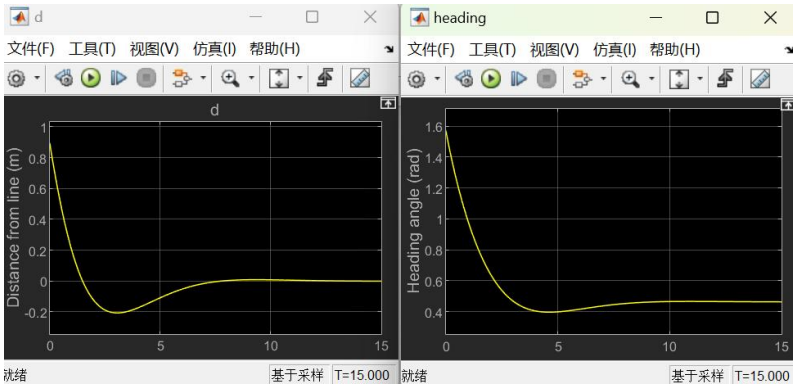
b) The trace of Drive to a Point in X-Y Plane:



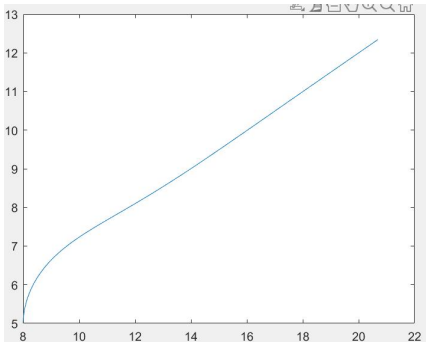
c) The speed, heading, steering wheel angle of Drive to a Point:



d) The heading and d(distance) of Drive along a line:

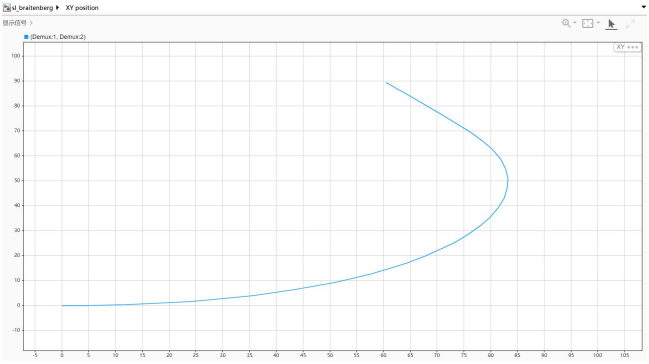


e) The trace of Drive to a Point in X-Y Plane:

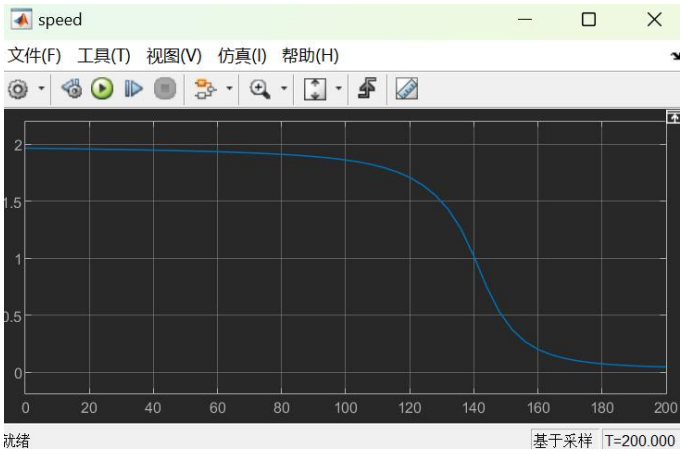


(2) Braitenberg vehicles:

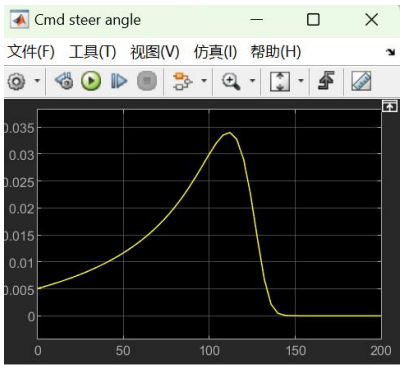
a) X-Y position of vehicles:



b) Speed of vehicles:



c) Steer angle of vehicles:



(3) The pseudocode of UCS:

```
function UCS(startnode, goalnode) // 函数定义
    create PriorityQueue PQ with Start Node // 创建一个优先队列
    create Dictionary PathCosts with Start Node // 记录每个节点的最佳路径的成本
    create Dictionary toPath with Start // 记录从起点到各个节点的最佳路径
    while PQ is not empty
        CurrentNode = Pop the node from PQ with the lowest path cost
        if CurrentNode is the goal
            return BestPath(CameFrom, start, CurrentNode) // 返回从起点到目标节点的最佳路径
        for each NeighborNode in GetNeiborNodes(CurrentNode)
            tentative_cost = PathCosts[CurrentNode] + Cost(CurrentNode, NeighborNode)
            if NeighborNode is not in PQ or tentative_cost < PathCosts[NeighborNode]
                PathCosts[NeighborNode] = tentative_cost
                CameFrom[NeighborNode] = CurrentNode
                if NeighborNode is not in PQ
                    Add NeighborNode to PQ with cost tentative_cost
                else
                    Update priority of NeighborNode in PQ to tentative_cost 、、更新

    return failure // 如果没有找到路径，则返回失败
function BestPath(CameFrom, start, goal)
    path = [goal] //重新开始并返回从起点到目标节点的路径
    while path[-1] ≠ start
        path.append(CameFrom[path[-1]]) //添加
    return Reverse(path)
function GetNeighborNodes(node)
    return NeighborNodes_list// 返回给定节点的所有邻居节点
function Cost(from, to)
    return cost_value // 返回从一个节点到另一个节点的成本
```

Experimental Results and Analysis:

(1) Car-Like Vehicle:

When the vehicle changes the direction as shown in the curves of steering angle, the value of Y smoothly decreases but the value of X slightly changes. In addition, the value of speed keeps the initial value along the process.

For the Drive to a Point, we know that the vehicle suddenly changes largely its steering angle as shown in its curves of steering angle, forward to final point, with its speed decreasing. When it arrives its final direction, it does not increase its speed, but remain unchanged.

For the Drive along a line, we know that the vehicle chooses to slightly change its direction twice to close to the direction of line. The straight distance between the vehicle and the line decreases, then increases and finally decreases to zero that means the vehicle successfully drives along the line.

(2) Braitenberg vehicles:

The graph of X-Y Position of Braitenberg vehicles above is similar to Fig 1, which clearly demonstrate that this vehicle moves toward the

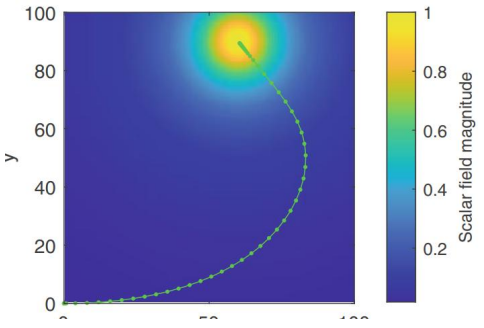


Fig 1

maximum of a 2D scalar field. In additions, from the results of speed and steer angle, we get that when vehicle is turning, the speed smoothly decreases.

指导教师批阅意见：

成绩评定：

指导教师签字：

年　　月　　日

备注：

注：1、报告内的项目或内容设置，可根据实际情况加以调整和补充。

2、教师批改学生实验报告时间应在学生提交实验报告时间后 10 日内。