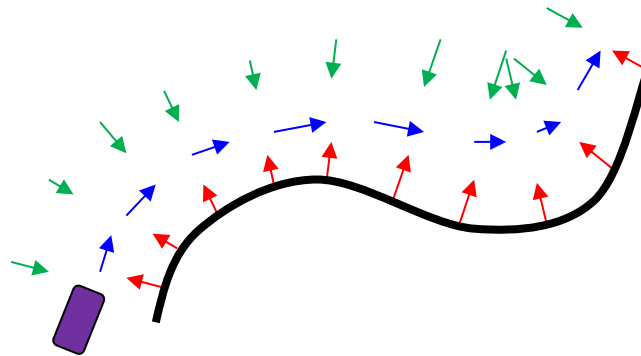


Assignment 5

Bonus for a total of 20%

1. **5%** of total grade) Use a potential field to guide the robot to the desired distance from the wall, e.g. 1 m and then use an attractive force parallel to the obstacle (perpendicular to the orientation the obstacle is detected) to move it along. Use attractive and repulsive forces similar to assignment 3. Using ROS and stage, write a program that will make the robot follow the closest obstacle. Save your data in a bagfile using *robag record*.



2. **5%** of total grade) **Particle filter propagation** (Individual) Using the motion commands of question 1 (bag file) implement a particle filter propagation model and plot the particle cloud as the robot moves. Experiment with different noise parameters.
3. **5%** of total grade) Using the potential field of question 1, implement a random walk algorithm, based on potential fields, by selecting a new destination randomly at short intervals. The only modification is at regular intervals, every 5 seconds for example, create a new goal:

$$X_{goal} = [x_r + r \cos(\theta) \quad y_r + r \sin(\theta)]^T \text{ where } r = rand(1) + 0.5, \text{ and } \theta = rand(0, 2\pi)$$

Use the code from question 1, no need to enter a destination. Experiment with "cave_single.world", and "obstacle_single.world" worlds.

4. **5%** of total grade) Use a potential field to guide a team of robots (use four robots) to swarm and follow a leader robot. The leader (robot0) should implement a behavior such as the one from question 2 or the random walk from Assignment 1. The rest of the robots (followers) should use repulsive forces for obstacles and also for the other followers. Robots are detected by the laser scanner. Filter out the LIDAR returns from the leader (do not be repulsed by robot 0). The attractive force for robot "j" should be:

$$\|F_a^j\| = \begin{cases} \frac{\alpha}{d_{j \rightarrow 0}^2}, & \text{if } d_{j \rightarrow 0} < d_{safe} \\ 0, & \text{if } d_{safe} < d_{j \rightarrow 0} < d_{far} \\ \gamma \cdot d_{j \rightarrow 0}^2, & \text{otherwise} \end{cases}$$

where $d_{j \rightarrow 0}$ is the distance between the centers of robot_j and robot₀ minus twice the radius of the two robots. A safe distance could be 1 m, and a too far distance would be 4 m. The above are approximate numbers.

Extend the code from question 2, create switch statement that modifies the behaviour depending on the Boolean isleader variable. If the robot is the leader then it uses the random walk from question 2. Otherwise, implement the follower behaviour. Run four potential_field programs in different terminals (or tabs). Experiment with “cave_multi.world”, and “obstacle_multi.world” worlds.

Notes:

Remember to run the command:

```
>rosdep update
```

Remember to run the command:

```
>. ~/catkin_ws/devel/setup.bash
```

Your assignment should consist of a pdf document that discusses your approach, difficulties and potential improvements, and a copy of your source code for verification purposes.