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CS309 - Autonomous Intelligent Robotics

Robot Collision Avoidance

I. Introduction/Problem statement:

Currently, the segbot does not possess the ability to perceive another robot as a robot and instead, sees the other as an obstacle and reevaluates a plan in order to get to the proper location whilst avoiding this "obstacle". However, due to this inability, in areas such as the square hallways connecting around the FRI lab, when two robots attempt to cross paths to reach separate destinations, they'll plan accordingly and take another path which causes them to meet on the other side of the lab and continuously come across the same problem. By executing a feature that allows each robot to recognize another, the robots would save time in terms of recalculating another pathway and potentially being stuck in a loop of recognizing the robot as an obstacle and trying to find a path avoiding it. In order to have each robot locate the other robots that are active on the floor, being able to find the coordinates of each active segbot and sending it to each bot nearby is key to having them avoid each other.

II. Proposed Approach:

With our planned approach, there are four key stages that the robot must reach in order to work as intended. In order to be able to register other segway bots on their map, the bot must first have access to the coordinates of other robots that are currently active on the same floor. Due to the Centralized Multi-Agent Status Server (CMASS), an active robot will upload its information onto the server and thus, a different bot or user can access the information and utilize it for future references. CMASS is a tool produced by the FRI lab by a current mentor, Walter Sagehorn, in which each robot uploads their activity, such as coordinates and allows us to use it for our project.

Due to CMASS, the robot is able to update and access the coordinates of each individual robot that is active. From this the coordinates of other robots must consistently be stored somewhere on the robot's system and thus, the segway bot must constantly check to make sure that its own path does not come across another robot's path. In order to do so, the robots will continue traveling their designated pathway until it comes across a blocking obstacle, and when this event occurs, each robot will grab coordinates of active robots and calculate whether the obstacle within their pathway is another segway bot or not. Though this may slow down the robot's speed when planning and traveling due to having to check if each blocking pathway is a robot, the segbot should only have to stop and access all the coordinates if there is no possible way to move alongside the other bot to its designated location.

After being able to register that an obstacle is a robot, automatica replanning should be halted and not occur within the segbot planning system. Once they both come to the conclusion that another bot is blocking its path and each bot cannot pass the other in the hallway, a new planning algorithm should be implemented. The robots should calculate which bot is closer to an open area and determine which robot has to move to avoid obscuring the other's path. The one who is calculated to be closer to a sideway path will temporarily navigate to an open area and wait until the other robot proceeds to pass. Then both will continue with their given tasks. However, if a bot is blocked momentarily by another, they should still register that a robot

passed in front of them, but should not have to recalculate a new pathway due to the obstacle disappearing shortly after.

Though we haven't dealt with similar techniques in past assignments, we hope to gain the help of mentors and teaching assistants who have dealt with similar ideas these past semesters. Past assignments, such as learning to localize the robot, do not go as far into depth as our project hopes to be, but allows us to gain knowledge and experience in terms of understanding the robot's map and localization in the area.

III. Evaluation of success:

Success of our proposed solution can be determined through various test cases. When two robots approach each other, each robot should recognize the other as a mobile robot, rather than as simply another obstacle obscuring its path. Once two robots encounter one another, each robot would utilize the connected LED String lights and change color when it successfully identifies the other as another operational robot. In addition, when two robots encounter each other and cannot plan paths to move around the other, one robot should backtrack on its course, allowing the other to proceed to its destination as originally planned. The level of success can be measured through experiments that have two robots move to the same location in various areas of different sizes. In large open areas, the robots should be able to move to the side and pass each other without having one backtrack on its course. In tight, narrow hallways with only enough space for one robot to pass through successfully, one robot should retrace its previous path and allow the other robot to continue on its original course. This should prevent two robots from repeatedly coming across each other and each planning a new route to avoid the robot they perceived to be an obstacle, only to run into each other again and repeat the cycle. If these tests execute successfully, our proposed project can be considered a success.

IV. Timeline:

Week 1 (4/2 - 4/8)

- Turn in project proposal
- Receive feedback from Mentors

Week 2 (4/9 - 4/15)

- Be able to receive the coordinates of active robots
- Figure out how to apply the coordinates into the robot's navigation system

Week 3 (4/16 - 4/22)

- Be able to have the robot detect another segway bot as a robot rather than an obstacle
- Figure out whether the robot should know if it's going to run into another ahead of time or have it detect a robot when it comes across it

Week 4 (4/23 - 4/29)

- Implement the algorithm of one of the robots backtracking to a location that allows the other bot to pass by

Week 5 (4/30 - 5/6)

- Finish code successfully
- Start report

Week 6 (5/7 - 5/13)

- Finish report
- Present final project

V. Expected Results:

While testing the success of our project, we expect each robot to successfully identify the other as a functional robot, rather than as objects. In addition, we anticipate to have both robots be able to navigate down the same hallway simultaneously, with one robot moving out of the way for the other, and then continuing on its original course.

VI. Potential Improvement:

Potential improvement for the project involves a number of possibilities. When two robots encounter each other in an area that prevents the two from avoiding collision by passing alongside each other, the decision of which robot should continue on the given course could be made through an evaluation of the importance of each robot's current task, or could be made through an evaluation of the difficulty of the paths the robots have to take in order to no longer obstruct the path of the other. This would be more beneficial than having a robot chosen at random to backtrack on its path to allow the other to pass.

In addition, instead of having the robots attempt to identify if an obstacle impeding its path is a robot, each path planned by the robot could be checked against the planned paths of other operating robots. This would ensure that two robots never cross paths in a tight area at the same time, ultimately preventing backtracking by one robot as the other passes. When two pre-planned paths cross at a location, another path could be planned by one of the robots to avoid the other robot.