Robotics: Assignment I

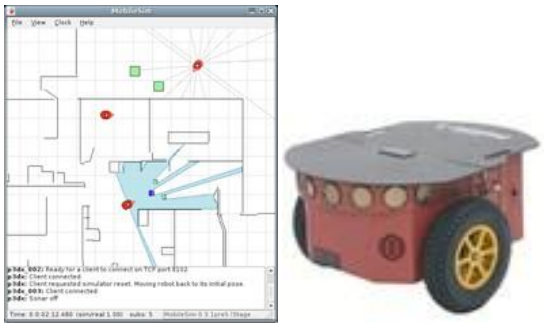
Pioneer 3-DX Simulation

Due: 2021/10/28 13:00 pm

Pioneer 3-DX is a mobile, differential-drive robot platform from Adept MobileRobots. MobileRobots provides the Pioneer SDK, a collection of libraries and applications, which help the users to control the robot platform and develop programs on it. In this assignment, you will learn how to use ARIA library to control the Pioneer robot and examine your program with the robot simulator, MobileSim.

ARIA is the core C++ library of the Pioneer SDK which provides an interface and framework for controlling and receiving data from the robot platforms.

MobileSim provides a simulation environment in which you can test your program on a simulated robot to make sure it works properly.



Part A: Getting Started

1) Install the ARIA library and MobileSim.
   ARIA: https://reurl.cc/W4dl2x
   MobileSim: https://reurl.cc/Qpdzr5
2) Start MobileSim and load the map named “Columbia” in the MobileSim directory. Try out following functions (If you don’t see them, it’s fine to skip this part):
   - [View]->[Position Data for all models]: show the robot position on the screen.
   - [View]->[Show Trails]: show the trail of the robot.
   - [File]->[Export]: record the process as images.
3) Run the ARIA demo program (/usr/local/Aria/examples/demo) and connect to MobileSim. Try out different operation modes (teleop, wander…).
   (Open MobileSim, then run “demo” file in terminal)

Part B: Building a C++ Program That Uses ARIA

1) Please refer to “/usr/local/Aria/README.txt” to find how to build a C++ Program on Linux.
   (Or try this : move your cpp file to /usr/local/Aria and run the following command
   c++ -fPIC -g -Wall -I/usr/local/Aria/include example.cpp -o example -L/usr/local/Aria/lib -lAria -lpthread -ldl -lrt)
2) We provide an example code (“example.cpp”) which can connect to a simulated robot. Try to

build this program and test it with MobileSim.

Note: If everything is working correctly, the simulated robot should keep moving forward until it bumps into a wall.

Part C: Keyboard Control

1) The ARIA demo program provides the "teleop" mode in which the user can navigate the robot with the keyboard. Try to implement similar functionality with ARIA library and name your source code "part_c.cpp". You are free to design the behavior of the robot when each key is hit (for example, hitting the left arrow will do a rotational motion when pushed and return it to zero when released); however, you must control the robot by setting the velocity directly. Do not use ArAction.

Note: You can try these functions: setVel(), setRotVel() (see the documentation on the Aria website)

Part D: Collision Avoidance using Sonar Sensor

1) When developing a robot, safety is always the first priority. What happened in Part B should be avoided. With the onboard sonar arrays, the Pioneer 3-DX is able to detect surrounding environment and respond to it. Try to get the readings and corresponding orientations from the sonar sensors.
2) Modify your keyboard control program and try to make the robot slow down when it is close to the obstacles to avoid a collision.

Part E: Robot Pose and Odometry

1) Robot pose includes robot's position (x, y) and orientation θ. With Aria, you can get the current robot pose by using the getX(), getY(), and getTh() functions, which are estimated by odometry. In MobileSim, you can get the true pose. *Is the odometric pose the same as the true pose? Why?*

   No, because the definition of the origin is different.

2) Devise a program that can move the robot to a specific target (true) pose, e.g. $(7, 5, \frac{\pi}{2})$. Let's use triangle.map located in "/usr/local/Aria/maps/" and assume the target is reachable. The program must take input from standard input with following format:

>>x y theta

(For example, if input is >>7 5 1.57, the robot should move to pose (7, 5, 1.57) accordingly.)

Name your source code "part_e.cpp".

Note: Input (7, 5, $\frac{\pi}{2}$) corresponds to (7000, 5000, 90) in getX(), getY(), getTh(). Reasonable error is tolerable. The initial true pose of the robot in triangle.map is (5090,3580,3093.97). You can try the moveTo() function.

Bonus Round: Obstacle Avoidance

Use the "obstacle.map" that is included in the zip file you got from NTU Cool. We will test obstacle

avoidance using this map by selecting a target pose (x, y, θ) across the obstacle. Your program should make use of the sonar information (as in Part D) to plan a local path around the obstacle to reach its target.

Note: You cannot pre-program a path around the obstacle. You must use the sensor input to receive credit for your program.

Name your source code “bonus.cpp”.

Evaluation Criteria

- Completeness: Part C, Part D and Part E run smoothly.
- Report: In English. Brief and concise.
- Tidiness: Proper syntax and indentation in your code.
- Bonus: Extra points depending on the performance of your algorithm.

Submission

1) Source code: Only part_c.cpp, part_d.cpp, part_e.cpp and bonus.cpp (if you decide to give it a try) are needed. Do not send the entire project to us. Please make sure your code can be successfully built and run before submission.
2) Report: Please describe your implementation of Part C, D and E and why you designed it that way. In part E, please elaborate on what is the difference between odometry and true pose in MobileSim. If you submit the bonus round, please briefly explain what kind of algorithm you used for navigation.
3) Demo video: Please record demo videos of Part C , D and E and upload them to google drive and provide the link in your report. Please remember to open the permission to access the video.
4) Save your report in PDF format, zip it together with your .cpp files and upload to NTU Cool. Name your zip file as <STUDENT_ID>_HW1.zip. For example, R10345678_HW1.zip

References

[1] ARIA Developer's Reference Manual at /usr/local/Aria/Aria-Reference.html