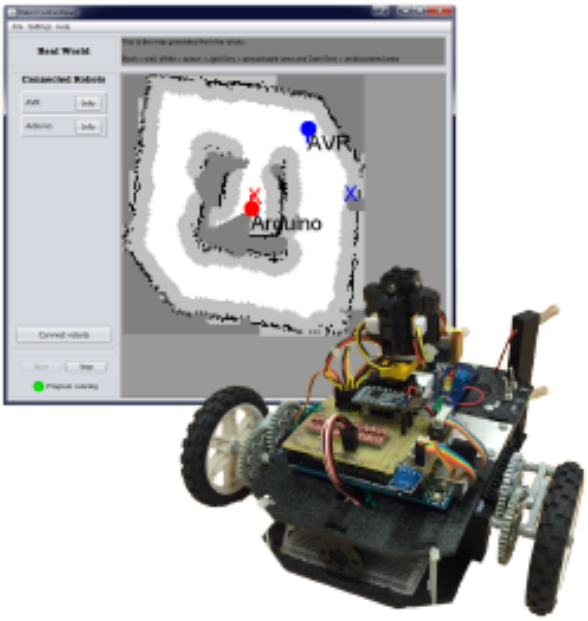
User Manual for "System for Self-Navigating Autonomous Robots"



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Chapter 1

Installation

1.1 Connect the dongle

Prior to starting the application, you have to connect the nRF51-dongle to your computer. Take the dongle containing the server software, and insert it into the USB-hub at your computer.

1.2 Find correct COM Port

1.2.1 Windows

- Press the Windows key
- Search for "Device manager" and click on it to open up the manager window
- Expand the "Ports" list and locate the NRF51-port[1]

1.2.2 Mac

- Press Command + space to enter spotlight search
- Search for System Information and click on it to open up the information window
- Select "USB" in the list and locate the NRF51 port

[1] May be named JLINK.

1.3 Get the application

In the appendices of the project report Lien (2017), you will find the application in the folder SSNAR Application. Copy the .zip file to the desired destination folder at your computer, unzip the archive and you are all set.

Chapter 2

Use

This chapter describes how the main application works, and how to enter the different modes. To learn more about the simulator and its functionality, see project report "Thon (2016)"

Be sure to follow the installation process as described in Chapter 1 before starting the application. Navigate to the folder where you unzipped the archive, and Double-click SSNAR to start the application.

2.1 Mode selection

The mode selection window is presented upon startup. The two different modes "Simulated world" and "Real world" decides if the application will use a real or a simulated reality. Select the desired mode, and the program continues to the application main window.

Figure 2.1: Mode selection

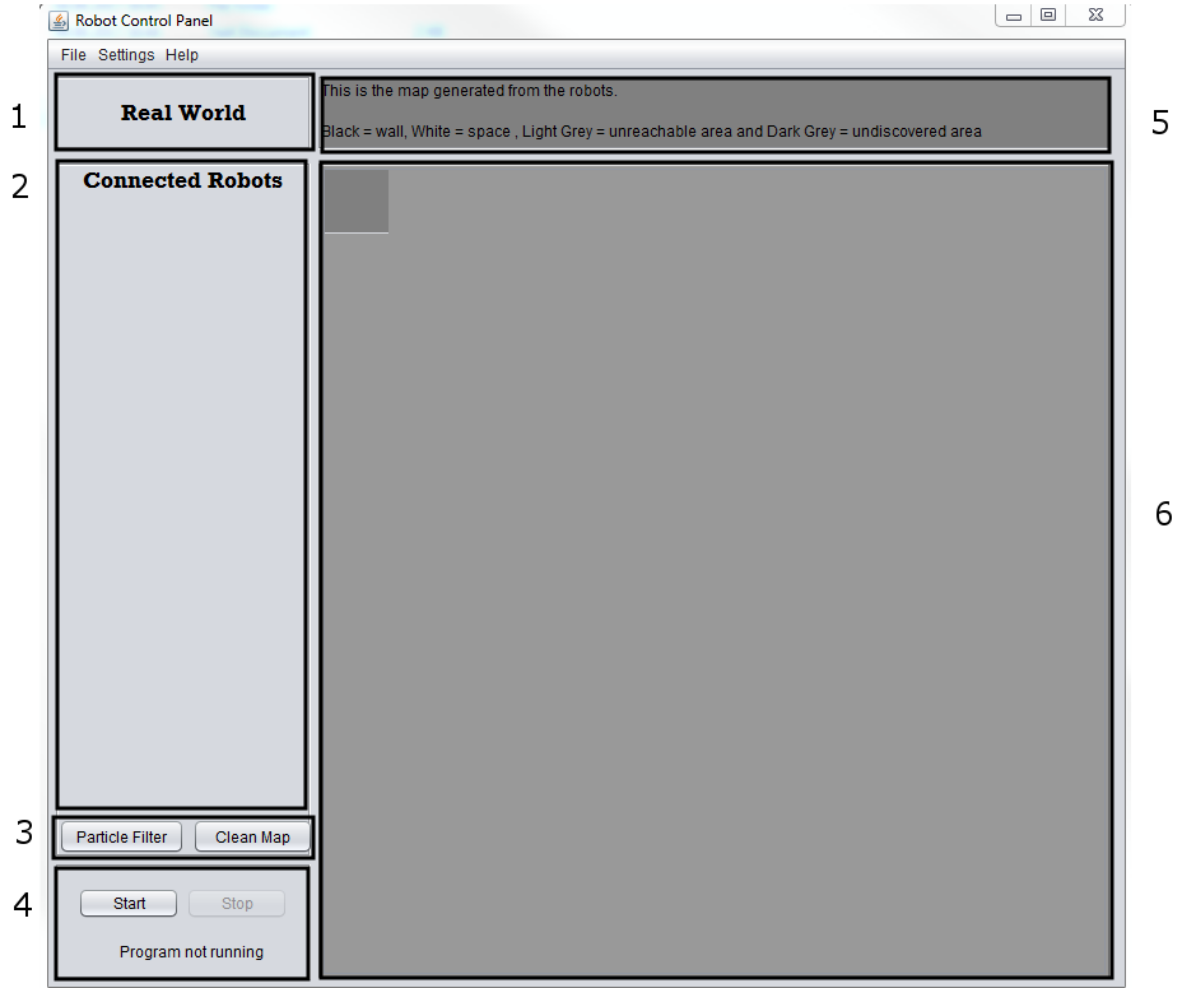

Figure 2.2: Main window

2.2 Main window

The main window, see Figure 2.2, is where you will spend the most of your time. It contains a limited amount of information about the different parts of the program and it provides buttons that let you access the programs features.

In the following list the parts of the main window are described (See Figure 2.2 for reference).

1. Mode title - This panel tells you which mode the program is currently running in.
2. Connected Robots - This panel will be updated with the connected robots (see Figure 2.5). Clicking the "More info" button will open up the Robot info window.
3. Particle filter - See section 2.8
4. Start/Stop - The start and stop buttons will start and stop the application.

5. Info - The information panel will display informative text as the mouse cursor hovers over the different parts of the GUI.

6. Map - The map will be painted in real time as the robots discover new areas (section 2.6).

2.3 Connect robots

When the robots are turned on they should appear in the "Connected Robots" list after a few seconds. If they do not appear, try restarting them.

2.4 Initial values

After the "Con" button is clicked, the application proceeds to the window shown in Figure 2.3. The position is relative to origo, and the units are in centimetre (angle in degrees). Be sure to input the correct values for the most accurate mapping of the area.[1]

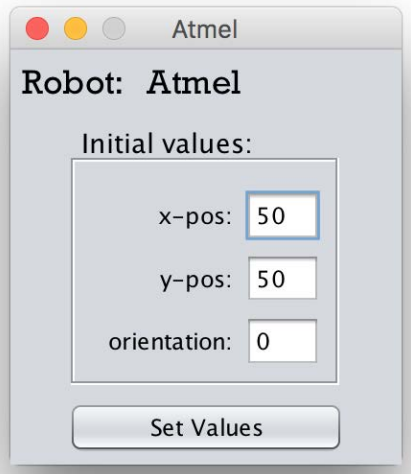

Figure 2.3: Set the robots initial position

[1]HINT: Let the first robot start in position (0,0) and place the rest of the robots relative to the first one.

2.5 Info

Clicking on the ”Info”-button associated with a given robot brings up the robot specific information window, see Figure 2.4. This window presents information about the robot such as name, position and orientation. The information is updated in real-time. Clicking the ”Disconnect Robot” disconnects the robot. The ”Manual Drive” button enables you to send commands to the robot. Enter values for both angle and distance, and click ”Send Command” (or press enter alternatively).

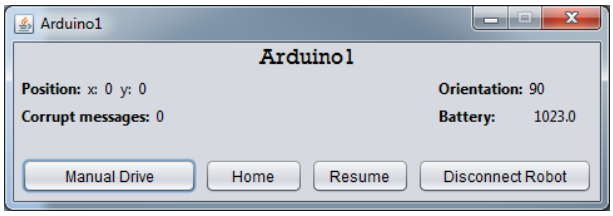

Figure 2.4: Robot-specific information

2.6 Map

When the robots are moving around and mapping the undiscovered area, the map will be updated in real time (see number 6 in Figure 2.2). The connected robots are shown as different colours with their name attached. Each robot has a pointer that shows its orientation, and a ”X” in the robots colours will illustrate where it is heading.

2.6.1 Colors in the map

See Figure 2.5 for an illustration of mapping in progress, and a list that describes the colours in the map.

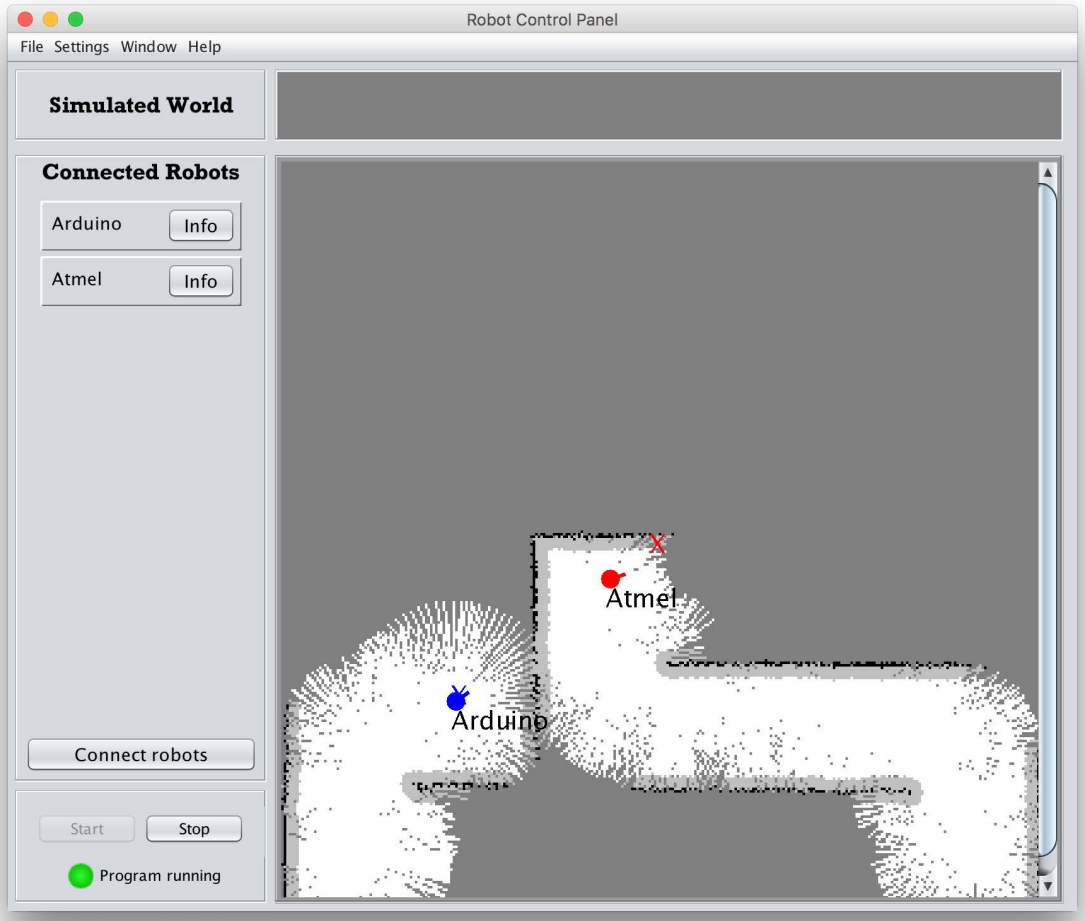

Figure 2.5: Real-time map plotting

- Black - discovered wall
- White - discovered space, no obstacle
- Light grey - unreachable area, due to collision avoidance
- Dark grey - undiscovered area

2.7 Docking sequence

The returning and docking sequence enables the robot to connect to the charger. This ability can be manually engaged by pressing the Home button in the Robot-specific information interface, see figure 2.4. The current voltage supplied by the battery can be seen in this interface as well. The application is programmed to force the robot to return if the voltage level dropps beneath 9.9 volts. When the robot has successfully docked to

the charger the mapping can be restarted by pressing the Resume button. See Strande (2017) for more information about this functionality. Only the AVR robot is equipped with this functionality as of now.

2.8 Particle filter

2.8.1 Particle filter usage

The particle filter is a way to improve the map estimate. The usage is simple:

1. Click on the Particle filter options button in the main GUI. See 3 in figure 2.2.
2. Hook off "Enable"
3. Select number of particles and other options
4. Press Accept
5. Run as normal

There are some parameters that can be tuned in the particle filter, such as the number of particles. When it comes to the number of particles, the more the better such that we can cover a larger set of pose hypothesis. The drawback is that it consumes more computational resources. Another thing to tune is the size of local frame. A larger frame gives more data points to compare and therefore a might ensure a more accurate match, but will also come at a higher cost, as all comparison happens at discrete time, simultaneous for all particles. A very large frame will often not have a very large overlap anyway, as the robot mostly traverse unexplored areas and the sensor data is noisy. The weighting acceptance factor adjusts how strict the resampling will be, a high factor will favour a few good particles, while a low factor will keep as diverse a collection as possible. A good balance is often a good approach. Lastly the uncertainty in the motion model can be adjusted. This sets the expected variance in a Gaussian motion model, and will effect how much the particles spread out. It is important not to make a to conservative assumption.

2.8.2 Map matcher usage

The map matcher is a way to merge separate maps from each robot into a complete map. The particle map must be active for this to work. After running with the particle filter, the "Particle filter options" button will now display "Map Merge". Press this

button and set the parameters. Iterations adjust the maximum iterations the simulated annealing will compute. If a good match is found, the function will return earlier than the maximum iterations. The temperature adjust the rate of random sampling in the simulated annealing algorithm, a high value may cause the map merger to take longer to converge, but will also more thoroughly search the state space. The CLock value is an important parameter that adjust how much overlap in the local maps the function expects. A low value (say zero) will assume a high value of overlap. Higher values will assume a lower level of overlap. When the parameters are set, press Start and wait while the program finishes. One map per robot should now appear, in addition to a merged map. The map may unsuccessfully merge, try adjusting the parameters, especially the Clock value and press "Retry?".

See the report of Melbø (2017) for more information.

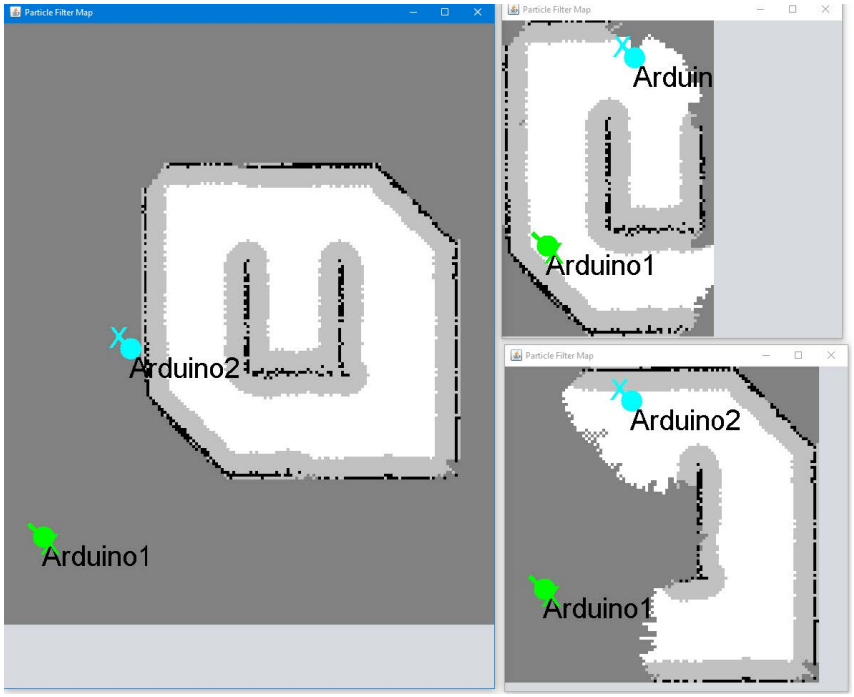

Figure 2.6: The merged map to the left, with the partial maps to the right.

Chapter 3

Glossary

COM Communication

GUI Graphical User Interface

SSNAR System for Self-Navigating Autonomous Robots