Introduction to Embedded Software and Applications

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2D Mapping using Single Ultrasonic Sensor

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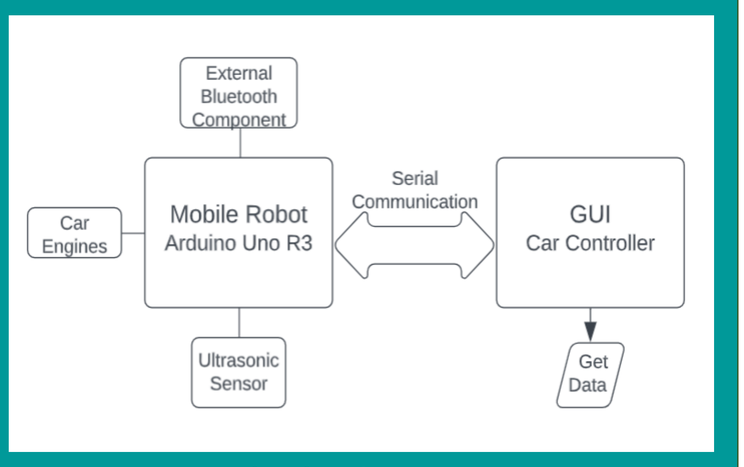
Introduction: As part of the final project in the course, we chose to combine several fields such as - hardware, software and robotics, and deepen the knowledge in them. The project is based on an article we found in the archives of the Delhi Technological University for Women. The project's goal was to develop a tool that would control a mobile robot, receive information from the sensor connected to it, process it, and present a type of mapping of the environment in which the robot is located.

System Requirements: For this purpose, we had to implement two main processes - the embedded software that would define the movement of the robot, receive the data from the ultrasonic sensor, process it, and send it to the computer via Bluetooth communication, and also the user interface that would receive the data, store it, and finally build the required mapping.

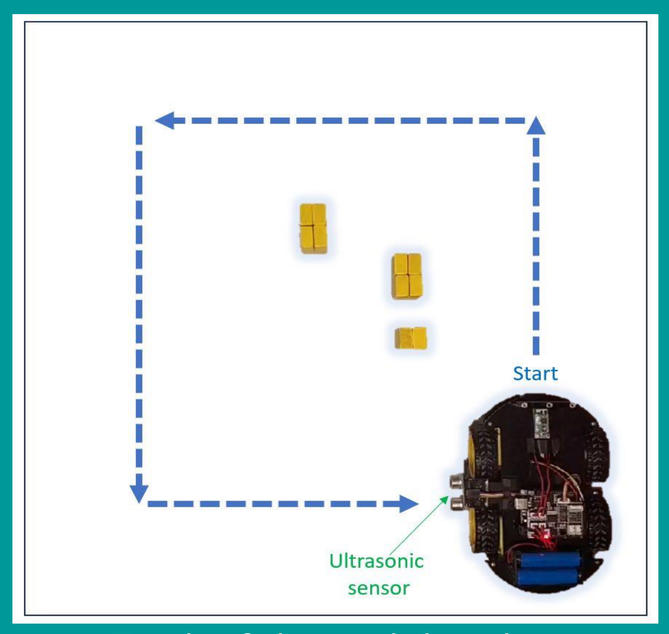
Characterization and execution: The mobile robot we used for the project is the Robot Arm Smart Car Kit manufactured by Lafvin. On top of the robot is an Arduino Uno R3 board to which you can connect different sensors in all kinds of configurations. In addition, there is an expansion board Motor driver shield, to which you can connect the motors and some sensors. After we assembled the kit and connected the sensor and motors to the relevant ports on the board, we defined the movement of the robot in the different directions and the reception of the data from the sensor. We configured the robot to work with an external Bluetooth component that allows receiving and sending data. On the one hand, the data from the ultrasonic sensor is sent to the GUI for processing and display, and on the other hand, the direction of the robot can be controlled through the GUI.

GUI: We wrote the GUI in Python, and for that we had to use the libraries - pyqt5, serial, numpy, matplotlib, seaborn, threading, and use topics we learned from other courses during our studies, such as data science and IoT. We based on the GUI we saw in the article and tried to achieve a similar result.

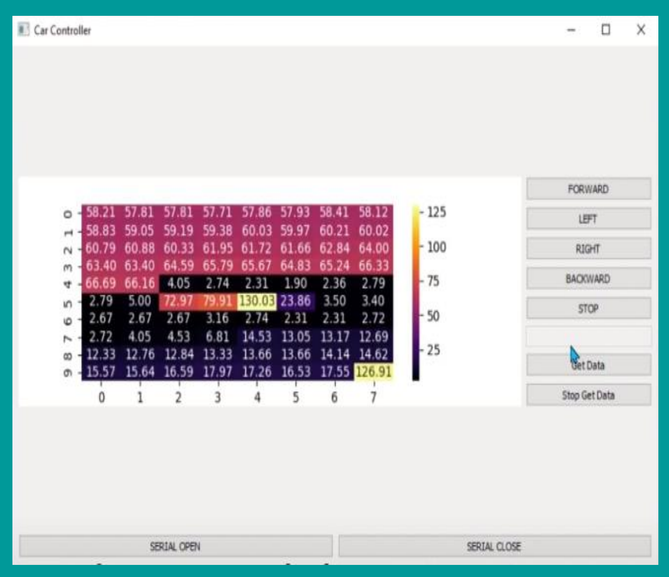
Summary: In conclusion, we succeeded to control the robot through the GUI, and transfer data from the robot to the GUI and vice versa. Moreover, we succeeded to achieve a pretty good result of mapping even when we used only one sensor. Looking ahead, the mapping results can be improved by working with an additional ultrasonic sensor (the board in our kit didn't support it), and the visualization of the GUI can also be improved by working with additional tools such as Matlab.



Block Diagram



Track of the mobile robot



GUI

GitHub

YouTube