

GoPiGo assignment

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1 Introduction

The practical assignment consists of the robot GoPiGo driving on the prescribed trajectory (driving between the three Andy green bottles). GoPiGo is placed in the opposite looking direction from the bottles, looking away from the wall. The robot is supposed to drive as quickly as possible to the first Andy bottle, do a slalom between the first and second bottle and then stop within 10 cm from the last bottle. To perform this, robot's camera should detect the bottles so that it is able to do the task correctly.

The trajectory is as presented below:

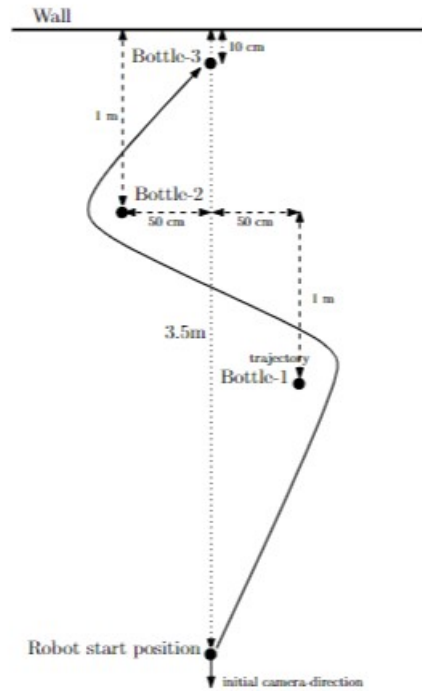


Figure 1: Format of the instruction set

2 Problem analysis and solution strategy

To solve this problem, the robot must be able to detect the bottles and avoid them and also be able to go to every bottle. By the use of the camera of the robot, it is possible to detect the bottles by their colors, using the OpenCV library. To receive more precise results, the frame around each bottle can be created so that it is able to get dimensions of the bottle and then allows the robot to choose the bigger bottle, which can cause problems in case of choosing a second bottle after avoiding the first one.

For the motors, the idea is to create states for performing the trajectory: Wake up, detect the first bottle, detect the second and third bottle and search them respectively, so that concludes six states in total. For each state, a separate function is written and then, another function is created so that the robot is able to perform them one by one.

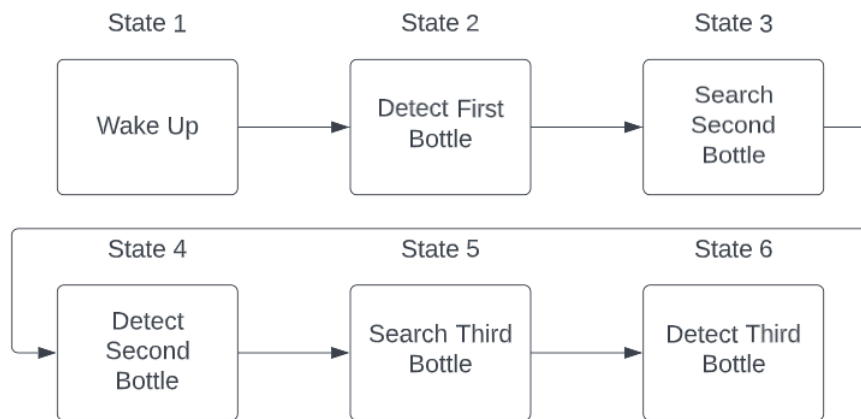


Figure 2: State machine diagram

Moreover, to let the robot go, it is needed to set certain speed for the motor. Lastly, it is essential to create two threads - for the camera and for the motor, so that GoPiGo can actually use functions related with camera and motor simultaneously.

One of the problems which was encountered, was the fact that the robot's trajectory was not consistent from one run to another, even though the parameters were not changing. In order to fix this, PID controller was implemented. That didn't fully fix the problem, but made the movements a little bit more consistent.

3 Description of the design/debugging

There were two main challenges it was needed to focus on: detecting the bottles and set the correct trajectory as well as control the robot's movement.

For the first one, as it was mentioned in the previous section, OpenCV library was used to process the image properly from the robot's camera. It was decided to do it detecting green colour of the bottle, so the function `createGreenMask` was created. Parameters for upper and lower bounds were set in order to make a mask which has the aim to detect the green colour by setting the right parameters for the threshold. Thanks to that, the camera only detects the bottles and not any other object with a similar color of the Andy bottles.

Having created the mask for the green colour, the function `drawContureOverBottle` was implemented to make a frame for each green bottle which was created to ensure, that the robot know where the bottle is. Furthermore, it allows the robot to see precise boundaries of the bottle and then, in the implementation of the motor, it is able to avoid the bottle from right, left or stop in front of it.

In order to make the robot stop within 10 cm from the last bottle we used the height of the bottle. This way, when the GoPiGo robot checks the height of the Andy bottle and sees that it exceeded a set threshold, it knows that there is an optimal distance between the robot and the bottle. By making use of the function "sleep", the robot can get as closer as it needs.

The debugging has been done by making multiple tests with the robot.

4 Conclusion

One thing that can be done to further reduce the time to complete the challenge is to make the robot spin faster when it's in the searching state. Currently, in the system, the camera is set on 40 fps because it was observed that it represents a good proportion between the resolution of the camera and the speed the robot needs in order to observe the bottles. Because of this limitation, the robot needs to move slowly at the beginning of the trajectory, so it has time to observe the surroundings and the position of the first Andy bottle.

From this assignment, we learned that in this project, as well as in every dynamic system, there are variables that don't depend on the system, but can effect it. For example, most of the times, the rotation sensors of the motors couldn't read the movements of the motors, creating a confusion in the system. Sometimes, the camera was blocked for a few seconds, making the detection of the surrounding delayed.