1 Test of implemented Hough Transform

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1.1 Introduction

The purpose of this test it to determine the reliability of the implemented marble detection algorithm, the Hough Transform for circles, at different ranges.

An error of 5% is an acceptable error.

1.2 theory

The Hough transform can detect partial objects [1], but that property is not of interest in this test. It does however influence how close the robot can be to the object before it can't detect it. Therefore it is expected that when the robot is so close to the marble that most of the edges are hidden from view, no marble is detected.

1.3 Experiment

1.3.1 Setup

The test will put the robot at different distances from the marble in the premade environment `smallworld.world` in the Gazebo folder. Multiple versions of this world, all with different start positions of the robot, has been made. A C++ program (`gzserver_manager.cpp` in the TEST folder) has been written to start and stop the gazebo server with the different worlds. For this test it also starts and terminates the `robot_control` executable, which is configured to log the average detection from the `hough()` function over a 100 samples.

The distance to the marble is 1 - 10 m, with a stepsize of 0.5, 19 tests in total.

The actual test is performed by the `testHough.hpp` in the folder fuzzy_andt_CV > scr. This program calls the `hough()` function and logs the average.

18 images of the camera for each run in the test is used to determine the true center coordinates and radius for each distance. This is to plotted against the detected values to compare and determine the error.

1.3.2 Procedure

Make sure the line `testHough(cam);` is uncommented in `main.cpp`. Navigate to the folder fuzzy_and_CV > CMake and write the command `cmake`, then `make` in the terminal.

Navigate to the folder fuzzy_and_CV > TEST, and compile the source file `gzserver_manager.cpp` (`g++ gzserver_manager.cpp`) and run the executable. This will perform the test and log the results in `houghData.csv`.

The python script `plotCSV_hough` is used to plot the results.

1.4 Results

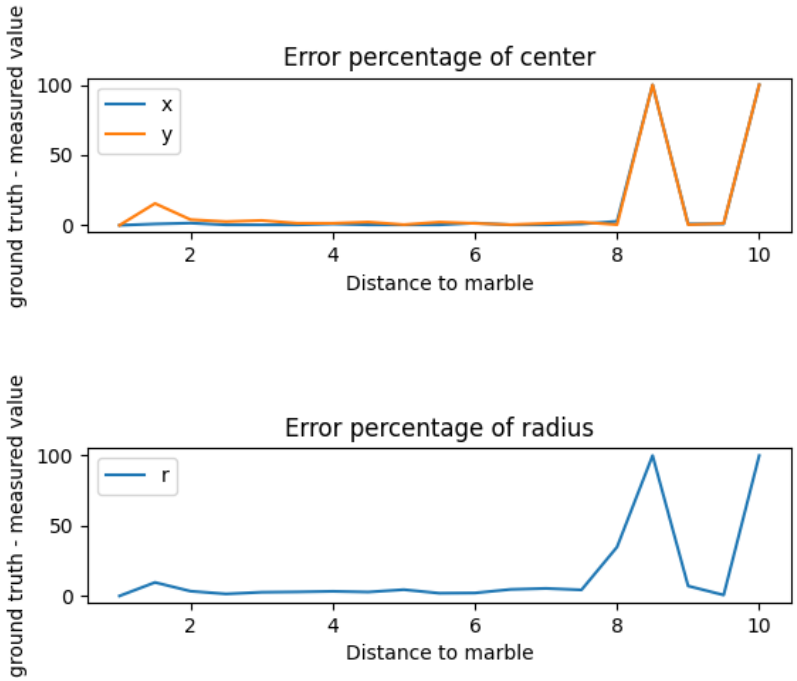

Figure 1: Test results of the error in percentage from the ground truth and the detection. The top plot is for the x- and y coordinated for the center, and the bottom plot is the radius.

It is seen from figure 1 that the error is close to zero in the range from 2 meters to 7.5. Beyond that point the error increases substantially.

In the most effective range, from 2- to 7.5 meters the error in percentage is on average 0.62% for the x coordinate, 1.93% for the y coordinate and 3.28% for the radius. That is an acceptable error.

1.5 sources of error

The 'ground truth' used to compare the results are measured from the same images that hough is tested on, but they are measured by hand using MatLab's `ginput` function. They are also integers and not floats unlike hough, that can have values in between pixels, thus rounding errors occur.

1.6 Conclusion

In the range of 2 meters to 7.5- the hough transform is a reliable method for detecting marbles. Further away the algorithm has trouble detecting the marbles.

2 Bibliography

[1] Kenneth Dawson-Howe. *A Practical Introduction to Computer Vision with OpenCV*. Wiley, 2014.