Test Sheet – Aid for the Blind People Project Submodule Test

Location	Middle East Technical University
Date	19 - 23 December 2022
Time	02:00 PM
Description	General submodule testing of the proposed design
Aim	Finding out the possible problems in each subunits and improving the systems according to the test results
Expected Outcome	Obtaining expected results from each subunit with minimum error margin
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Test Devices & Tools

1. Measurement Tape and Iphone Measure Application (Measure)

Ground truth: The distances and heights of the detected objects are measured with a measurement tape. After that, these distances are measured with Measure Application and the performance of the application can be verified. After that, due to fast measurements of the Measure Application, the following measurements will be held with the mobile phone.

2. Iphone Measure Application (Levels)

Ground truth: The angle of the ultrasonic distance sensor will be measured with Measurement Application (Levels) of the Iphone as well. The calibration of the application will be done by putting the mobile phone on a vertical plane such as a table.

3. STM32CubeIDE on Host Computer

Ground truth: By using the Live Expressions feature of the Debugger in STM32CubeIDE, the real time outputs of the subunits can be displayed. This system is the main development interface of our subunit microprocessor. No calibration is required.

4. Bluetooth Terminal HC-05 on Host Device

Ground truth: This application is the mobile application of our Bluetooth Module to test our bluetooth module. By using this application, the data can be displayed on a mobile phone's screen. The calibration will be done by AT commands.

5. FPS Measurement Tool on Host Device

Ground truth: A well known FPS measurement algorithm will be used to obtain the camera performance of our system while the object detection algorithm is running. The system parameters will be predefined for calibration of the algorithm.

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Test Environment

As the test environment, the desired detected objects are mainly chosen from the Middle East Technical University Campus area. The environment consists of pedestrian crossings, traffic lights, speed bump signs, and cars, whose existence and shape should be detected as the testing process. Coming cars as the potential dangers for the user should be detected and the user must be warned. The aim of the test environment is to test the image detecting/distance measurement modules.

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Test Parameters

Parameter	Range	Step Size	Number of Points
Obstacle Detection Distance	[30 cm, 150 cm]	20 cm	7
Shape of the Obstacle	Objects with different shapes will be tested due to the nature of the ultrasonic waves	A planar object A cylindrical object An object with sharp edge An object that absorbs the sound waves	4
Performance of the Ultrasonic Distance Sensor Varying with Relative Angle with Respect to Ground	[0 degrees,45 degrees]	22,5 degrees	3
Car Detection Distance	[1 m, 20 m]	1 m	20
Car Detection Accuracy vs Distance	[1 m, 20 m]	1 m	20
Traffic Sign Detection Accuracy vs Distance	[1 m, 5 m]	1 m	5
Traffic Lights and Pedestrian Crossing Detection Distance	[1 m, 11 m]	2 m	6
Traffic Lights and Pedestrian Crossing Detection Accuracy vs Distance	[1 m, 11 m]	2 m	6
Image Processing Algorithm Precision vs FPS	[2 FPS, 16 FPS]	1 FPS	15

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Test Procedure

1. Measuring the distance of a planar object from different distances with varying angles as described above.
2. Measuring the distance of a cylindrical object from different distances with varying angles as described above.
3. Measuring the distance of a sharp object from different distances with varying angles as described above.
4. Measuring the distance of a sound absorbing object from different distances with varying angles as described above.
5. Detect a car starting from 1 m to 20 m.
6. Detect multiple cars which are at the same distance to obtain the accuracy of the detection algorithm.
7. Detecting varying traffic signs with a high accuracy ratio given by our algorithm from different distances.
8. Detecting traffic lights and pedestrian crossings starting from 1 m to 21 m.
9. Detect multiple traffic lights and pedestrian crossings which are at the same distance to obtain the accuracy of the detection algorithm.
10. Fixing the fps rate of the algorithm to test its precision as mentioned above.

Test Data

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Table 1: Obstacle Detection Distance and Angle for a Planar Object

Obstacle Detection Distance and Angle for a Planar Object	Actual Performance	Expected Performance	Error
30 cm and 0.00 degrees		29-31 cm	
30 cm and 22.5 degrees		29-31 cm	
30 cm and 45.0 degrees		29-31 cm	
50 cm and 0.00 degrees		48-52 cm	
50 cm and 22.5 degrees		48-52 cm	
50 cm and 45.0 degrees		48-52 cm	
70 cm and 0.00 degrees		67-63 cm	
70 cm and 22.5 degrees		67-63 cm	
70 cm and 45.0 degrees		67-63 cm	
90 cm and 0.00 degrees		86-94 cm	
90 cm and 22.5 degrees		86-94 cm	
90 cm and 45.0 degrees		86-94 cm	
110 cm and 0.00 degrees		105-115 cm	
110 cm and 22.5 degrees		105-115 cm	
110 cm and 45.0 degrees		105-115 cm	
130 cm and 0.00 degrees		124-136 cm	
130 cm and 22.5 degrees		124-136 cm	
130 cm and 45.0 degrees		124-136 cm	
150 cm and 0.00 degrees		143-157 cm	
150 cm and 22.5 degrees		143-157 cm	
150 cm and 45.0 degrees		143-157 cm	

Table 2: Obstacle Detection Distance and Angle for a Cylindrical Object

Obstacle Detection Distance and Angle for a Cylindrical Object	Actual Performance	Expected Performance	Error
30 cm and 0.00 degrees		29-31 cm	
30 cm and 22.5 degrees		29-31 cm	
30 cm and 45.0 degrees		29-31 cm	
50 cm and 0.00 degrees		48-52 cm	
50 cm and 22.5 degrees		48-52 cm	
50 cm and 45.0 degrees		48-52 cm	

70 cm and 0.00 degrees	67-63 cm
70 cm and 22.5 degrees	67-63 cm
70 cm and 45.0 degrees	67-63 cm
90 cm and 0.00 degrees	86-94 cm
90 cm and 22.5 degrees	86-94 cm
90 cm and 45.0 degrees	86-94 cm
110 cm and 0.00 degrees	105-115 cm
110 cm and 22.5 degrees	105-115 cm
110 cm and 45.0 degrees	105-115 cm
130 cm and 0.00 degrees	124-136 cm
130 cm and 22.5 degrees	124-136 cm
130 cm and 45.0 degrees	124-136 cm
150 cm and 0.00 degrees	143-157 cm
150 cm and 22.5 degrees	143-157 cm
150 cm and 45.0 degrees	143-157 cm

Table 3: Obstacle Detection Distance and Angle for a Sharp Edged Object

Obstacle Detection Distance and Angle for a Sharp Edged Object	Actual Performance	Expected Performance	Error
30 cm and 0.00 degrees		29-31 cm	
30 cm and 22.5 degrees		29-31 cm	
30 cm and 45.0 degrees		29-31 cm	
50 cm and 0.00 degrees		48-52 cm	
50 cm and 22.5 degrees		48-52 cm	
50 cm and 45.0 degrees		48-52 cm	
70 cm and 0.00 degrees		67-63 cm	
70 cm and 22.5 degrees		67-63 cm	
70 cm and 45.0 degrees		67-63 cm	
90 cm and 0.00 degrees		86-94 cm	
90 cm and 22.5 degrees		86-94 cm	
90 cm and 45.0 degrees		86-94 cm	
110 cm and 0.00 degrees		105-115 cm	
110 cm and 22.5 degrees		105-115 cm	
110 cm and 45.0 degrees		105-115 cm	
130 cm and 0.00 degrees		124-136 cm	

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130 cm and 22.5 degrees	124-136 cm
130 cm and 45.0 degrees	124-136 cm
150 cm and 0.00 degrees	143-157 cm
150 cm and 22.5 degrees	143-157 cm
150 cm and 45.0 degrees	143-157 cm

Table 4: Obstacle Detection Distance and Angle for a Sound Absorbing Object

Obstacle Detection Distance and Angle for a Sound Absorbing Object	Actual Performance	Expected Performance	Error
30 cm and 0.00 degrees		29-31 cm	
30 cm and 22.5 degrees		29-31 cm	
30 cm and 45.0 degrees		29-31 cm	
50 cm and 0.00 degrees		48-52 cm	
50 cm and 22.5 degrees		48-52 cm	
50 cm and 45.0 degrees		48-52 cm	
70 cm and 0.00 degrees		67-63 cm	
70 cm and 22.5 degrees		67-63 cm	
70 cm and 45.0 degrees		67-63 cm	
90 cm and 0.00 degrees		86-94 cm	
90 cm and 22.5 degrees		86-94 cm	
90 cm and 45.0 degrees		86-94 cm	
110 cm and 0.00 degrees		105-115 cm	
110 cm and 22.5 degrees		105-115 cm	
110 cm and 45.0 degrees		105-115 cm	
130 cm and 0.00 degrees		124-136 cm	
130 cm and 22.5 degrees		124-136 cm	
130 cm and 45.0 degrees		124-136 cm	
150 cm and 0.00 degrees		143-157 cm	
150 cm and 22.5 degrees		143-157 cm	
150 cm and 45.0 degrees		143-157 cm	

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Table 5: Car Detection Distance

Car Detection Distance	Actual Performance (Detected/ Not Detected)	Expected Performance (Detected/ Not Detected)	Error
1 m		✓	
2 m		✓	
3 m		✓	
4 m		✓	
5 m		✓	
6 m		✓	
7 m		✓	
8 m		✓	
9 m		✓	
10 m		✓	
11 m		✓	
12 m		✓	
13 m		✓	
14 m		✓	
15 m		✓	
16 m		x	
17 m		x	
18 m		x	
19 m		x	
20 m		x	

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Table 6: Car Detection Distance vs Accuracy

Car Detection Distance vs Accuracy	Actual Performance (Out of 10)	Expected Performance (Out of 10)	Error
1 m		10	
2 m		10	
3 m		10	
4 m		10	
5 m		10	
6 m		10	
7 m		10	
8 m		10	
9 m		10	
10 m		10	
11 m		10	
12 m		10	
13 m		10	
14 m		10	
15 m		10	
16 m		9	
17 m		9	
18 m		9	
19 m		8	
20 m		8	

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Table 7: Traffic Sign Detection Distance vs Accuracy

Traffic Sign Detection Distance vs Accuracy	Actual Performance (Accuracy %)	Expected Performance (Accuracy %)	Error
1 m		90-95%	
2 m		90-95%	
3 m		90-95%	
4 m		75-85%	
5 m		75-85%	

Table 8: Traffic Lights and Pedestrian Crossing Detection Distance

Traffic Lights and Pedestrian Crossing Detection Distance	Actual Performance (Detected/ Not Detected)	Expected Performance (Detected/ Not Detected)	Error
1 m		✓	
3 m		✓	
5 m		✓	
7 m		✓	
9 m		✓	
11 m		✓	

Table 9: Traffic Lights and Pedestrian Crossing Detection Accuracy vs Distance

Traffic Lights and Pedestrian Crossing Detection Accuracy vs Distance	Actual Performance (Accuracy %)	Expected Performance (Accuracy %)	Error
1 m		50-70%	
3 m		80-90%	
5 m		75-85%	
7 m		70-80%	
9 m		50-70%	
11 m		50-70%	

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Table 10: Image Processing Algorithm Precision vs FPS

Image Processing Algorithm Precision vs FPS	Actual Performance (Precision)	Expected Performance (Precision)	Error
2 FPS		75-80%	
3 FPS		75-80%	
4 FPS		75-80%	
5 FPS		80-85%	
6 FPS		80-85%	
7 FPS		80-85%	
8 FPS		80-85%	
9 FPS		85-90%	
10 FPS		85-90%	
11 FPS		85-90%	
12 FPS		90-100%	
13 FPS		90-100%	
14 FPS		90-100%	
15 FPS		90-100%	
16 FPS		90-100%	

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Data Analysis

(To be filled after the test)

Determine appropriate methods for analyzing and presenting the test data (plots, diagrams, tables, etc.). Provide meaningful statistical analysis.

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Results and Discussion

(To be filled after the test)

Interpret the results of your test by providing a detailed assessment of the performance and data analysis. Determine whether your tests are successful or not. Deduce meaningful conclusions and determine the next steps.