**Senior Design**

ENG EC 463

**Autonomous Legged Guide Robot**

**Team 2**

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**Required Materials:**

Hardware:

1. OAK-D Camera (with cables)
2. TOF Lidar
3. Raspberry Pi
4. Puppypi robot dog

Software:

1. VNC Viewer

**Setup:**

OAK-D test:

The OAK-D should be connected to the robot dog via cable. The implementation of a gyro function has been built inside the raspberry pi. Upon running the script, the terminal of the VNC viewer will return the relative angle the camera is facing and the output should change with the angle of turning.

Lidar test:

The lidar needs to be installed on top of the robot dog and is used to perform obstacle detection. When an obstacle is detected within a certain distance, lidar will return information about the upcoming obstacle to the robot dog to perform the most optimal obstacle avoidance procedure.

Line tracking test:

Prior to running the function test, red tapes need to be taped on the ground as the desired route. Functions are implemented in the robot dog to detect red-colored lines and perform link tracking upon running.

QR code test:

QR codes used in this test are from the “april\_tag” repository. Prior to running the tag recognition test, QR codes have to be taped at certain locations, for instance, on doors or walls of the room. An earphone has to be connected to the robot dog via Bluetooth and the user needs to wear the earphone. Once a certain tag is detected, the raspberry pi will record the information of the room (room number, floor number, etc) and provide voice feedback of the stored information to the user via earphone.

**Pre-testing Setup Procedure:**

Robot Dog test:

The robot dog should be turned on. A WLAN hotspot with SSID starting with “HW-1a” should be detectable. The computer needs to connect to the hotspot. Then, use the VNC software to connect to the onboard Raspberry Pi. The IP address should be 192.168.149.1, the username should be “pi”, and the password should be “raspberry”. After connection, a graphical desktop should be visible. For file transfer, WinSCP is needed. It can log in using the exact same credentials. Once these are done, the setup is complete.

**Testing Procedure:**

OAK-D test:

1. Set up the environment and hold the camera with hand facing a certain angle
2. Record the relative angle output of the current position.
3. Turn the camera to a different angle.
4. Record the updated angle and compare the results to check the accuracy.

Lidar test:

1. Add obstacles on the path of the robot dog.
2. Start running the script.
3. Record the interaction between the dog and the obstacle.

Line tracking test:

1. Tape red lines on the floor (with turns).
2. Put the robot dog on the starting point with red lines visible to the dog.
3. Start running the script.
4. Check if the dog can follow the tape to walk toward the desired destination.

QR code test:

1. Connect the earphone to the dog via earphone, wear the earphone
2. Start running the script.
3. Tape the tag at certain locations
4. Let dog walk close to the tag
5. Check if the correct voice feedback is heard on the earphone

**Measurable Criteria:**

OAK-D test:

1. The terminal window should be able to display output from the OAK-D camera
2. The output turning angle should match the actual turning angle within certain margin of error

Lidar test:

1. The robot dog should be able to detect the obstacle on the path and perform a detour to avoid the obstacle.
2. The robot dog should be able to return to its original path once it has passed the obstacle.

Line tracking test:

1. The dog should be able to walk toward the path once it has detected the red line.
2. The dog should be able to follow the line toward the destination even in the presence of turns in either direction.

QR code test:

1. The dog should be able to detect the QR code and output the information stored in each QR code to the earphone.

**Score Sheet:**

| Objective | Correct? |
| --- | --- |
| In OAK-D camera test, the margin of error of turning angle is within 土 10° | No. The margin of error is not stable and exceeds 土 10°. |
| Robot dog can avoid the obstacle and walk back to its original path | Yes. |
| Robot dog can follow the red line to the destination | Yes. |
| Robot dog can provide correct voice feedback for all 3 QR codes | Yes. |

**Conclusion:**

There were 4 tests for our second prototype test. As shown in the score sheet, the overall performance of the robot was reasonably good as it only “failed” one of the four tests.

We started with the OAK-D camera test. The original objective was to have the margin of error for the turning angle to be within 土 10°. During the actual test, even though with proper stability and around 20 seconds, the gyro result generated by the OAK-D can be stabled within the desired range, the time it takes to reach the stabilized result is considerably long for our scenario therefore the test is considered a “half failure”. However, the gyro utilized in our current design is the ToF LiDAR which is capable of generating accurate results for line tracking and obstacle avoidance tests. Therefore, the OAK-D camera is our extension idea that can be used in future developments and should not yield a severe consequence with such failure.

Our second prototype test is the obstacle avoidance test. Due to the limitation of space in the lab, we decided to perform the test at our home and present video recordings of the test. The test result is successful as the robot is capable of locating the obstacle beforehand, performing detours, and finally getting back to its original tracks after passing the obstacle.

For the line tracking test, the test was also presented with the video due to the same limitation. Since we chose a red line as opposed to a black one, the robot dog is cleared from false detection issues and performed sufficiently well on the test. The line tracking is successful with straight lines and routes with turns. Therefore, the line tracking test is considered a success.

Finally, for the QR code test, we performed the test in the lab. The process of QR code detection, QR code recognition, output conversion, and voice feedback on our speaker went smoothly. With the sufficiently performance, the test is successful.