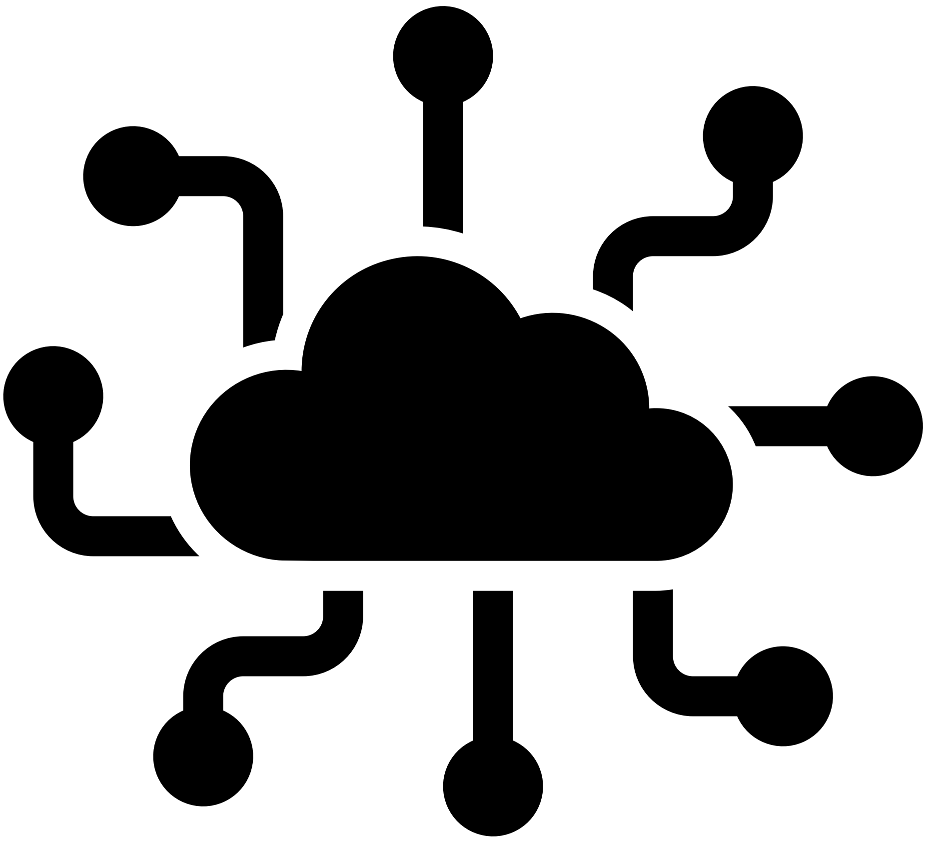
City of Things prototyping kit

HOGESCHOOL ROTTERDAM, PROJECT 7/8
ONDERZOEK – LIDAR



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Eerste gelegenheid 12-06-2022

Changelog

Version	Date	Alteration	Author
1.0	07/04/2022	First version	Leandro de Nijs
1.1	08/04/2022	Tests done	Leandro de Nijs & Tom van Pelt & Auke Blankwaard & Yuan Zhu & Ian Zuiderent
1.2	08/05/2022	Document addition	Leandro de Nijs
1.3	29/05/2022	Document addition	Leandro de Nijs
1.4	04/06/2022	Small changes	Tom van Pelt

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Summary

In this research it is made clear that a LIDAR is not a viable option. This is concluded by performing several tests, such as: obstacle recognition and map generation. The results of the performed tests are as follows: the LIDAR generated a map, but the map was noisy and not a particularly good representation of the classroom. Furthermore, the LIDAR is unable to detect glass, so the laser of the LIDAR went through the glass and was not seen as a wall. In addition, the LIDAR did not detect the obstacles in the set time. This made us advise against the use of LIDAR.

Introduction

The commissioning parties City of Things Lab010 and Knowledge Centre Creating 010 want to investigate how smart initiative-based connected objects in the smart city (automatic delivery vehicles or safety robots) change daily life and whether they have a positive or negative impact.

For this project, a prototype is to be made in the form of a driving robot that can drive autonomously or remotely (or otherwise). The prototype is intended for designers and non-expert citizens with limited programming knowledge. The prototype must therefore be easy to operate and set up.

The proposal that was thought up by the project group is to make a kind of waiter robot that can be used as an example of what is possible and what kind of smart objects are possible in everyday life. This robot could be used in a restaurant to autonomously bring food and drinks to a specific table.

To navigate to the waypoints (tables), the waiter robot needs to be able to get a view of its surroundings, such as obstacles and people. The waiter robot also needs to construct a map of the location is it in. For these things a sensor is needed. Literature research in sensors is made, but the chance to assess a LIDAR appeared. So, to further support our decision experimental research will be done.

Methodology

This research is experimental research. A couple of tests will be done. The observations will be written down and analysed. A recommendation will be made based on the conclusion and the results of the tests.

Why LiDAR?

"LIDAR sensors use laser, giving these sensors many advantages. Again, we list some of these advantages, as well as disadvantages:

Advantages

- **These sensors detect 360° around the sensor.**
  Because LIDARs are so fast, these sensors can measure distance in 360°. This allows you to get a good overview of what is happening in front, to the side and behind.
- **These sensors are accurate and reliable.**
  Because LIDAR sensors work with a laser, these sensors are very precise. A LIDAR is accurate to the centimetre.
- **These sensors are not affected by ambient light.**
  Because these sensors use their own very small and precise light source, they will not be affected by external light sources. This makes it easier, unlike ultrasonic, to use multiple sensors at the same time. You can also use this sensor in a place with little ambient light.
- **These sensors are very fast.**
  Because these sensors operate at the speed of light, these sensors are many times faster than ultrasonic sensors.". (I. Zuiderent (2022, March 9))

Tests

Question

- Is a LiDAR sensor applicable for SLAM?

Measuring set-up

- Measuring instruments:
  - RPLIDAR A1M8
  - Raspberry Pi 4b 4gb
  - 5-meter USB cable
  - ROS running on Pi
  - RVIZ for visual feedback
  - RTABMAP for mapping
- Set-Up:
  - Connect the RPLIDAR A1m8 to the Raspberry Pi using the provided USB connector in de RPLIDAR box.
  - Install the package 'rplidar' from http://wiki.ros.org/rplidar and follow the instructions.
  - The LiDAR provides 2D mapping. For viewing the map open RVIZ
  - The test location is a classroom.

External conditions

- The room provides obstacles for the LiDAR to detect and has glass windows to determine if the LiDAR detects glass.
- Stable underground for the LiDAR.
- Environment light.

Operations

- Walk around the room a couple of times to map the room.
- Analyse each map provided by the LiDAR for usability and accuracy.
- Put obstacle in front of LiDAR at three different distances (0.2m, 1m, 3m.).
- Turn the light in the classroom on and off to evaluate if the accuracy changes.

Data to record

- Map of the classroom.
- Time to detect a new obstacle.
- Accuracy of glass windows.
- Accuracy with change of light

Requirements

- The map generated by the LiDAR is in accordance with the room.
- The time to detect a new obstacle is under one second.
- The LiDAR detects glass windows and sees them as walls.
- The accuracy of the LiDAR does not change under different environment lighting

Observations

- Map of the classroom.
  - The LIDAR was able to generate a map of a classroom. But the map was not exactly accurate. In the map there was substantial noise present, as can be seen in the video listed in the appendix.
- Time to detect a new obstacle.
  - The LIDAR was slower than one second. The time it took for the LIDAR to update the obstacle in the map was close to 5 seconds.
- Accuracy of glass windows.
  - The LIDAR was unable to detect the glass windows of the classroom, as can be seen in the video listed in the appendix.
- Accuracy with change of light
  - No difference in accuracy was noticeable from light to dark and dark to light.

Analysis

- It will be determined if the LIDAR provides a solution of the set requirements.
- An analysis is made of the observations.
- The map needs to be in accordance with the room and there must not be any noticeable noise.
- The time that it takes for the LIDAR to detect an obstacle will be recorded using a stopwatch.
- The LIDAR will be held in front of the glass windows of a classroom. In the map will be seen if the LIDAR detects these glass windows.
- The light conditions will be changed from a lit room to a dark room.

Results

The LIDAR generated a map. The map was noisy and not a particularly good representation of the classroom. An explanation for this was that the room was surrounded by glass windows. The LIDAR is unable to detect glass, so the laser of the LIDAR went through the glass and the glass wall was not seen as a wall. Another reason for the slow and bad results were that the LIDAR sends vast amounts of data, which were sent over an USB extension cable which may resulted in loss of data. Furthermore, the LIDAR did not detect the obstacles in the set time. A positive result is that the accuracy of the LIDAR did not change with the change of light.

Conclusion

The LIDAR was unable to meet all the set requirements. The LIDAR was inaccurate, slow and was unable to detect glass windows. This means that the LIDAR is not a good fit for the waiter robot.

Recommendations

Our recommendation is choosing another sensor and not a LIDAR.

References

I. Zuiderent (2022, March 9). Sensors.

Appendix

There is a video of the LIDAR demonstration in the same folder as this research.