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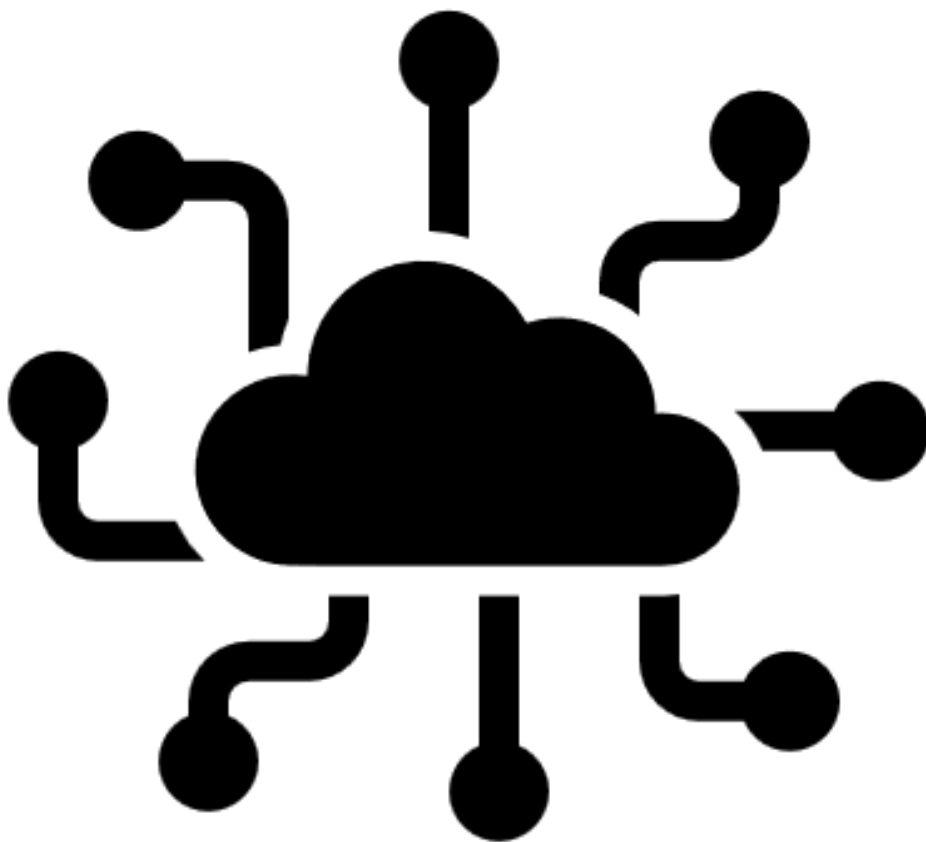
HOGESCHOOL ROTTERDAM, PROJECT 7/8

ONDERZOEK – DELIVERING ROBOT

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Changelog

Version	Date	Changes	Author
1.6	10/04/2022	Executive summary	Yuan Zhu
1.5	05/04/2022	Conclusion was added	Yuan Zhu
1.4	03/04/2022	Comparison and implementable were added	Yuan Zhu
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1.1	20/03/2022	Introduction	Yuan Zhu
1.0	18/03/2022	Initial version	Yuan Zhu

Abbreviation table

Abbvreviation	Explanation
SLAM	Simultaneously localization and mapping
UWB	Ultra-wide banded
RGBD	RGB-Depth

glossary

Term	Explanation
HackerBoard	The hacker hoverboard on which our project is based on.
SLAM	SLAM is the computation problem of updating a map of an unknown environment while simultaneously keeping track of an agent's location within in
LIDAR	Light detection and ranging. LiDAR is a method for calculating distance using a laser sensor.

Summary

The expected result of our project is an Ober robot that will deliver food to the assigned table. Therefore, we want to make research on existing ones and see what functionality they have already and what they use to see what we can implement from them. For this we are going to research 4 different existing Ober robots namely:

- BellaBot
- KettyBot
- PuduBot
- KeenonBot

BellaBot is the most friendly-looking out of the four. This one may attract the most customers just based on the design. Due to many smart animations that play with different interactions, it makes it livelier. On top of that, it has a light indicator indicating which direction it is turning. It is mainly used to deliver food and has an advertisement LED panel in the back. Finishing with the price of around 15 to 20 thousand per unit

KettyBot is more of a reception robot than an Ober robot. but it still has trays where food can be put on that's why it was included. It has an 18.5-inch Display in the front where customized advertisements can be made and put. In the back, it had a removable cover, detachable and attachable trays. Finishing with the price of around 12 thousand per unit.

PuduBot is more of a simplistic robot. it has a minimal-looking interface on top that shows show animation to interact with customers. Contains four trays for food transporting. Also includes a dish cover. That is a plexiglass box. Finishing with the price of around 12 thousand per unit.

KeenonBot is also of a more simplistic side. What's special about this unit is that I can adjust its own speed depending on the environment. This also comes with four trays. Mostly focuses on delivering food to its destination. This unit cost around 10 thousand per unit.

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Introduction

The expected result of our project is a waiter robot that will deliver food to the assigned table. for this we will be using a Hackerboard, our own customized version of a hoverboard. This Hackerboard will be avoiding obstacles and people on the way to the table, and it will be able to map the environment that it is supposed to work in so that it can deliver the food to the destination. The board is also aware of its own location on the given map. This is also known in our world as a delivering robot or Ober robot. There are many types that are already made to be used in restaurants. The purpose of this research is the find how the published Ober robots work, and what functionality they have. That can be implemented in our Hackerboard.

Methodology

For this research we will use all the available resources there is to find online. Including articles, websites, news, product's websites. The sources will be checked for their authenticity and accuracy in today's world (2022).

Ober robot

What is an Ober robot?

An Ober robot is a robot that delivers food or drinks to the assigned table. It can be also called a delivery robot. As of today (the year 2022) it is still rarely seen in restaurants around the world. The countries that use this the most are China and Japan. Depending on the type of Ober robot it could have only one tray or multiples trays for food/drinks.

For the following part, we are going to talk about several types of Ober robots and what functions they have.

- BellaBot
- KettyBot
- PuduBot
- KeenonBot

Bella Bot

Bella Bot is the most friendly-looking Ober robot on the market. It has mainly a cat design and animations that react to interaction with the robot. depending on the situation animations will be played for the corresponding situation. Bella bot uses an industry-exclusive dual SLAM solution for full coverage in any scenario. Namely Laser SLAM and visual SLAM. The visual SLAM in this scenario is used more for objects in the space around it and the laser SLAM for mapping the inner space of the restaurant. The tray for food includes a weight sensor and a light that turns on an object placed on top of it. On top of that, there are also lights indicating which direction it is turning when he's moving around. For obstacle detection, this robot uses a 3D omnidirectional Obstacle Avoidance technology in pursuit of higher safety. It can stop at any angle and move away as soon as it encounters an obstacle. It has a minimum height for object detection which is 2cm, 193 degrees front detection angle and has a frequency of 5400 detections per minute. For safety measures, the speed is adjustable between 0.5-1.2 meters per second and the climbing angle must be smaller than 6 degrees. The market price for the Bella bot is unknown since it is not made public by the company. However, using others as examples it should be around 15 to 20 thousand dollars per unit.

Bella Bot	
Robot weight	55 kg
SLAM System	Visual and Laser SLAM
Number of trays	4
Max load capacity per tray	10 kg
Obstacle Avoidance Sensor type	3D Omnidirectional Obstacle Avoidance
Speed	0.5-1.2 m/s
Max Climbing angle	5 degrees

Extra functionality

- There's a light on the edge of the tray that turns on when food is placed on top of it
- Light indicator when it turns to the corresponding direction.
- A LED screen in the back for custom advertisement
- Smart interactions – when an interaction is made with the robot it responds with different types of smart animations to feel more like a cat.

KettyBot

KettyBot is a delivery and reception robot with an advertisement display. It has a yellow design with a big LED screen in the front where custom advertisements can be placed. On top of that, it has an eyeball animation to make it look more friendly and attract customers. The trays in the back can be detached or reattached when needed. There's an additional cover when the trays are not attached to cover its back. You can use the interface to make a delivery on multiple tables with accurate positioning and optimal path planning. This robot also uses a Dual SLAM Navigation system consisting of a laser and visual SLAM. Lastly, he has an automatic recharge function where he goes back to its charging station when the battery is low. The market price of this Bot is around 12 thousand.

KettyBot	
Robot weight	38 kg
SLAM System	Visual and Laser SLAM
Number of trays	2
Max load capacity per tray	15 kg
Obstacle Avoidance Sensor type	Visual and Laser SLAM
Speed	Max 1.2 m/s
Max Climbing angle	5 degrees

Extra functionality

- Automatic recharge function – KettyBot has a dock station where it can go back automatically to recharge when the battery is low.
- It has a big advertisement display that is 18.5 inches big. Customized advertisements can be made and displayed.
- Detachable and re-attachable trays.

PuduBot

PuduBot is simplistic in many ways. It has a small user interface where animations get played to make it more friendly. it uses PUDU SLAM. It is a new technology integrated SLAM solution based on lidar, camera UWB, RGBD, IMU, Encoder, and multiple sensors. This solution can ensure that the robot performs tasks more efficiently in a mixed environment. It also uses 3D stereo sensors that can quickly stereo model the surrounding environment, which can greatly reduce the chances of accidents. It comes with an extra accessory which is a dish cover that is made of plexiglass. It is easy to install and the door opening method is a magnetic switch. The market price for this bot is around 12 thousand

PuduBot	
Robot weight	35 kg
SLAM System	PUDU SLAM
Number of trays	3
Max load capacity per tray	10 kg
Obstacle Avoidance Sensor type	3D stereo sensors
Speed	0.5-1.2 m/s
Max Climbing angle	5 degrees

Extra functionality

- Dish cover – an additional attachment that can be installed on the bot. made of Plexiglass, weight 8 kg, the door opens with a magnetic switch.

KeenonBot

KeenonBot is also a simplistically designed robot. it has its own SLAM positioning and navigation technology. It includes sensors and multi-sensor fusion algorithms such as encoder, IMU, lidarodom, LIDAR, image module, UWB, and WIFI. This ensures a high positioning accuracy and robustness. For obstacle avoidance, it uses LIDAR, depth vision, stereo vision, collision sensor, and infrared ranging depth vision that combines into an omnidirectional obstacle sensing system. What's unique about this robot is it has a Smart region speed limit function. The speed limit changes according to the environment it is in. for example on normal flat grounds it goes 1 meter per second but on a slope, it changes to 0.3 meters per second. Using this function makes it adapt better to different environments. The market price for this one cost around 10 thousand per unit.

KeenonBot	
Robot weight	55 kg
SLAM System	Keenon SLAM
Number of trays	4
Max load capacity per tray	10 kg
Obstacle Avoidance Sensor type	3D stereo sensors
Speed	Max 1.2 m/s
Max Climbing angle	5 degrees

Extra functionality

- Environment speed adjustment – it adjusts to a proper speed depending on the environment.
- Smart expression – makes it look friendlier.
- Flexible structure – able to change the height difference between the trays
- Adjustable trays

Comparison

For the following part, we will be comparing the basic data between the four bots to get an average or the most used type so we as a team know we are in the right direction with our development of the project.

- Robot weight – the weight of the robot varies between 35 and 55 kg.
- SLAM system – the most common ones are visual and laser SLAM excluding the custom-made SLAM systems that the companies use.
- Number of trays – 3 to 4
- Max load capacity per tray – 10kg
- Obstacle avoidance sensor type – 3D stereo sensors
- Speed – 0.5-1.2 m/s
- Max climbing angle – 5 degrees
- Average price – 10 to 15 thousand per unit

Is it worth it?

The average price for a unit is around 10 to 15 thousand per unit and the average salary of a waiter/waitress is 1680 euros per month or 20,100 yearly (data used from salaryexplorer.com). We can see within a year you can already get a return on your investment. It also helps you attracts customer due to the design of the robots and because the majority of the restaurants do not use such robots it makes your restaurant more unique. It is still unclear how often you need to do maintenance on your robot and how much maintenance would cost. Even with the maintenance costs, it should be worth it as a long-term investment for your restaurant.

Implementable

Here we check what functionality we could implement in our project.

User interface – A display where you could click on a button, so it goes to a certain checkpoint/waypoint.

Emergency stop button - On top of the Ober robot we could put a big red emergency button. When pressed it stops running. In case of emergency or accidents, it can be immediately stopped.

Weight sensor for tray – it is possible to implement a weight sensor to determine if the food was delivered or not. This way we can make the Ober robot more automatic.

Stereo sensor – for obstacle avoidance

SLAM – Visual and Laser SLAM

Conclusion

To conclude this research, we found a few suitable techniques/functionalities that are implementable in our projects. This doesn't mean It will get implemented. But further research is needed on all options to see if they are suitable or not.

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