# COMPA - COMPRA

**Autonomous Shopping Cart**


**Autonomous University of Barcelona (UAB)**
**School of Computer Engineering - Robotics 2025**

Universitat Autònoma de Barcelona

Pol Tomé,
Adrià Fernandez Mata,
David Madueño Noguer,
Tiago David Nunes Rodrigues,
Moisés Sánchez Pin


May 9, 2025

# Contents




**Abstract**

Compa-Compra is an autonomous shopping assistant that guides and assists the store user to complete their shopping easily and simply. The user communicates with ComCom through an application where products are specified. **Make your list and ComCom will guide you!**

[Aquí habría que añadir unas pinceladas de los resultados y funcionalidades]


# 1 Introduction

The act of shopping is a daily activity, but it is not always efficient. Whether due to the difficulty of finding products, congestion in the aisles, or the need to compare options, navigating the supermarket can become a tedious task. **Compa Compra** is an autonomous assistant designed to improve the shopping experience for any user, regardless of their profile, age, or specific needs.

Through a multimedia application, the customer enters their shopping list, and the ComCom robot processes the best route within the establishment using advanced localization and path planning techniques. Thanks to the **D* Lite** algorithm and the use of **Bluetooth** beacons, **Compa Compra** optimizes shopping time and facilitates efficient access to each product.

# 2 Theoretical Framework and Contextualization

The **CompaCompra** project is based on two key areas of robotics and autonomous navigation: **2D localization** using trilateration and route planning with **D* Lite**. These concepts allow the assistant to guide the user within the supermarket with precision and adaptability.

## 2.1 2D Localization

One of the main challenges of autonomous navigation is **indoor localization**. To determine **ComCom**'s position, 2D trilateration is used with four fixed Bluetooth beacons in the corners of the supermarket.

The method uses the measurement of the **Received Signal Strength Indicator (RSSI)** from each beacon to estimate the distance between the robot and the fixed references. However, the RSSI signal can be affected by interference, so **filtering and error correction** techniques, such as moving average and Kalman filter, are applied.

Once the estimated position $(x, y)$ is obtained, it is adjusted to the nearest supermarket grid cell, defined as a mesh of **0.5m$^2$ per node**. This process allows for a discrete representation of the navigation space and facilitates route calculation.

For more information on trilateration, consult the documentation: Trilateration on Wikipedia

## 2.2 Path Finding Algorithm: D* Lite [TO BE REWRITTEN]

The optimal movement of the robot is managed by **D* Lite**, an efficient route-finding algorithm in dynamic environments. Based on the user's position and the products on the shopping list, the system calculates the ideal trajectory on the node grid.

Each node in the supermarket can be classified as:

- **Free:** traversable areas without obstacles.
- **Occupied:** areas blocked by shelves, obstacles, or other customers' carts.

Initially, all known obstacles are considered, but the path is **dynamically recalculated** if **ComCom** detects new impediments during its journey. This allows the robot to adapt in real-time to changes in the environment.

For more information on **D* Lite**, consult the documentation: D* Lite on Wikipedia

# 3 Description of the CompaCompra System [TO BE WRITTEN, THESE ARE JUST GUIDE POINTS TO DEVELOP]

## 3.1 General Architecture

- System block diagram (integration of hardware, sensors, beacons, and app)
- Description of the main modules

### 3.2 2D Localization

- Description of the node grid (supermarket area modeled as $0.5m^2$ nodes)
- Function of Bluetooth beacons and RSSI-based position estimation
- Position correction and rounding process

### 3.3 Pathfinding

- Details on the D* Lite algorithm and its use for optimal route calculation
- Consideration of obstacles and dynamic updates to the route

### 3.4 User Interaction

- Communication flow between the multimedia application and the robot
- User interface and steps to generate the shopping list

## 4 Methodology

- Description of the implementation of various algorithms and techniques
- Tools and technologies used (software, hardware, communication protocols)
- Testing and validation procedures, including simulated or real supermarket environments

## 5 Analysis of Results and Evaluation

- Presentation of localization test results (accuracy, error rate, response to obstacles)
- Comparison between planned and actual trajectory
- Use of graphs and tables for visual representation of results
- Evaluation of user-robot interaction and feedback
- Graphical documentation (e.g., videos, photos or environment schemes)

## 6 Discussion

- Interpretation of results in relation to stated objectives
- Identification of limitations and possible error sources (e.g., RSSI signal interference, supermarket layout changes)
- Improvement proposals and reflections on system applicability in other environments

# 7 Conclusions and Recommendations

- Summary of the most relevant findings
- Impact of the Compacompra system on the shopping experience
- Recommendations for future research or improvements in design and functionality

# 8 Bibliography / References

- List of all sources consulted, following a consistent citation style (APA, IEEE, etc.)
- Inclusion of technical documentation, articles, and Wikipedia entries (e.g., on trilateration and D* Lite)

# 9 Annexes (Optional)

- Relevant source codes
- Additional system diagrams
- Raw data or complete test results
- Graphical documentation (e.g., photos or environment schemes)