Exploiting semantic information in indoor environments

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Institute of Informatics
Postgraduate Program in Computing

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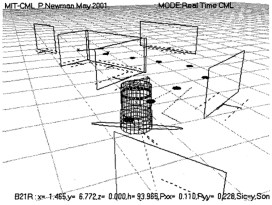
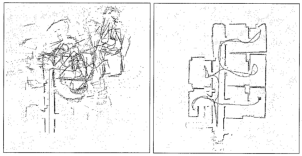
First years of mobile robotics

- Ages of mobile robotics:
  - Classical age (1986-2004)



(a) Real Time CML[1]



(b) Online mapping[2]

Figure: Initial works on SLAM

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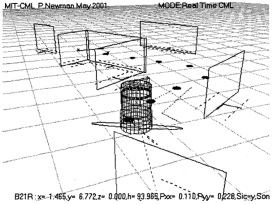

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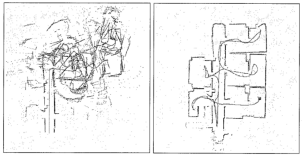

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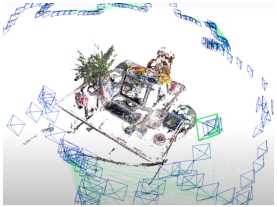

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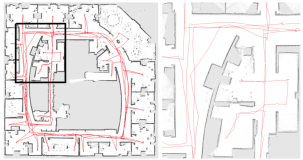

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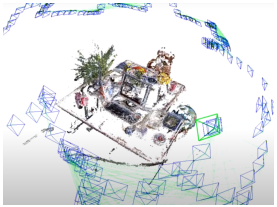

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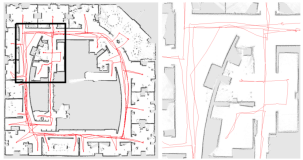

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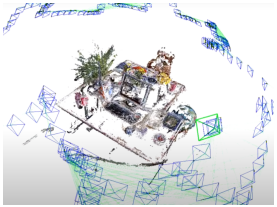

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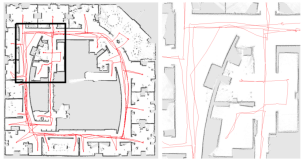

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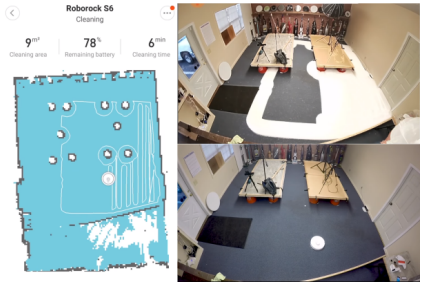

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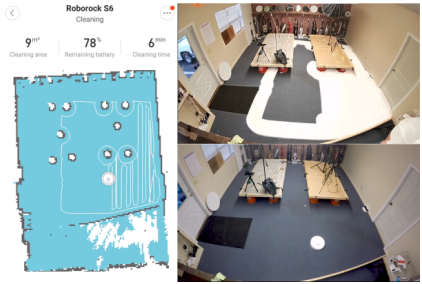

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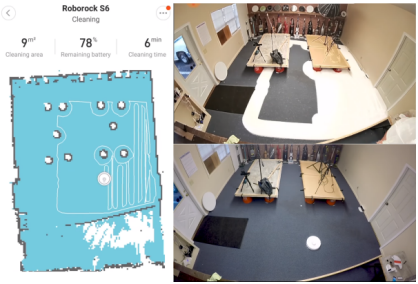

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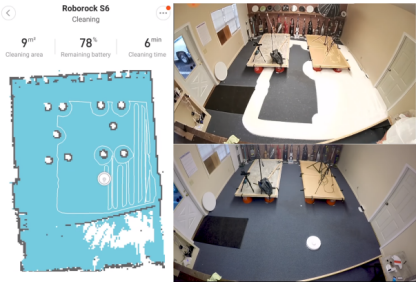

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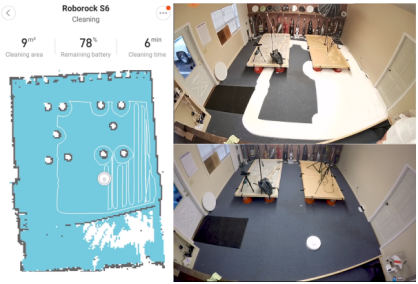

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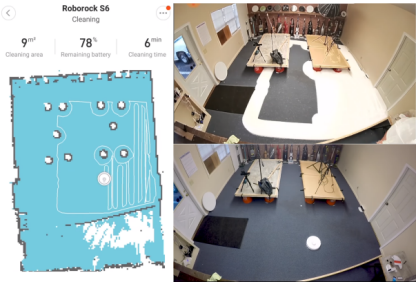

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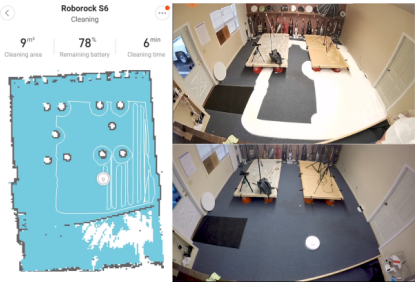

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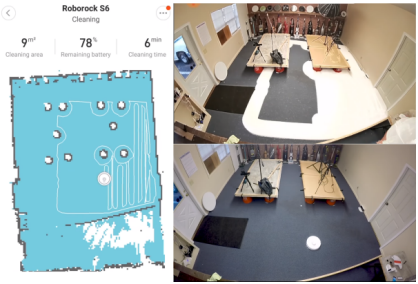
- How to **overcome** these **limitations**?



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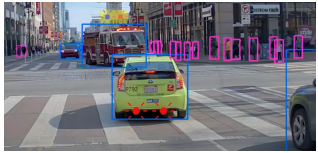
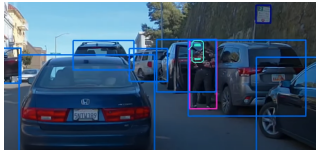


(a) The sire of the fire truck



(b) The car door

Figure: Self-Driving System of an autonomous driving car.[6]

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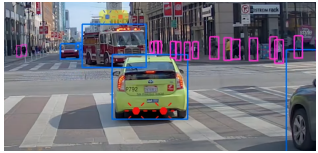

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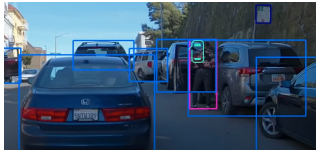

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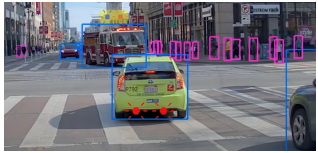

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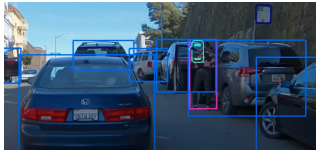

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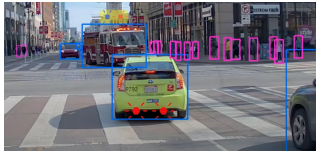
- Essential for **high-level reasoning**



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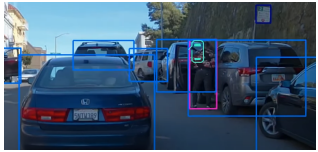

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Hypothesis

Semantic information *associated with the* **spatial** *and* **temporal organization** *of the environment help mobile robotics to* **overcome** *the* **limitations** *to deal with* **high-level tasks**

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- We **investigate** this questions in the context of a **high-level task**: **object search** (OS)

Object search (OS) task

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  - Semi-dynamic obstacles

Problems involved in this work

- **Mobile robotics** problems:
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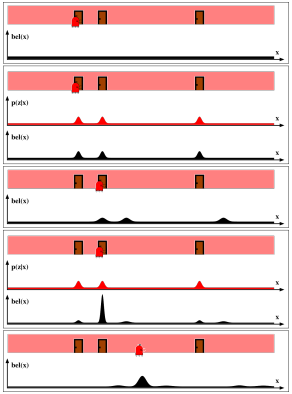

Figure: Illustration of the Markov localization algorithm.[7]

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Figure: Mapping with position indexed by odometry.[8]

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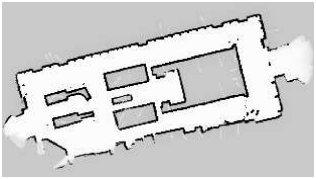

Figure: Occupancy grid map.[9]

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Text *as* **source** *of* **semantic information** *for visual* **object search** *in large and* **unknown environments**

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- Level of abstraction of the environment

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  - Textual information and organization of the environment
  - Analysis that highlights the advantages of the use of semantic information

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Map Segmentation module

- Simultaneously to the Mapping module
- Divides the map based on the free space
- Kernel Density Estimation (KDE)
- An abstraction of the 2D grid map for grouping the detected door signs

Image Processing module

- Optical character recognition (OCR)

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- The recognized numbers are associated to the map segments

Semantic Planner module

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Growing Direction

- The

Parity

- The

Door and Robot Orientations

- The

Distance

- The

Final formula

- Semantic part

Final formula

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Final formula

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- Geometric part
- Combination

Experiments and Results

- Simulated experiment setup

Experiments and Results

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- Maps:

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- Maps:
  - Normal

Experiments and Results

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Experiments and Results

- Simulated experiment setup
- Maps:
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- Greedy OS system

Experiments and Results

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Experiments and Results

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Experiments and Results

- Human participants in OS task

Experiments and Results

- Physical Robot

Summary

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- Analysis of the difficulty of the OS problem by the experiments with human participants

Temporal semantic OS system based on heat maps

Introduction

- Service robots and their use in indoor environments

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- The advantages of visual sensors for the OS problem

Humans-object interaction

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- Most of the robotic approaches ignores semi-dynamic or dynamic objects
- Understanding how the objects are moved throughout a period of time may help in the OS problem
- Realistic (the environment changes) and customized (adapts to the local habits and routines) OS system

Proposal and contributions

- Semantic temporal OS system for indoor environment

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- Self-contained OS system

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- Advantages of semantic information from dynamic environments
- Searches based on the request hour

System overview

- Two modes OS system:

System overview

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System overview

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  - Requesting mode

The OS system

- Heat map

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- Heat map
- Kernel angle reduction

The OS system

- Heat map
- Kernel angle reduction
- Inverted kernel

The OS system

- Goal computation

Experiments and results

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- HH106 dataset

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Experiments and results

- Maps

Experiments and results

- Maps
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Experiments and results

- Maps
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  - Static-Inv

Experiments and results

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Experiments and results

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Experiments and results

- Maps
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  - Static-Inv
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Experiments and results

- Results for each map:

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- Search space reduction that provides better placement for the robot
- Temporal Semantic OS system that observes the objects' position changes throughout a period of time
- An OS system that does not depend on a specific SLAM or object-detection algorithm
- Analysis of the advantages of using semantic information inferred from semi-dynamic objects

Discussion and Thesis Progress

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Ongoing and future work

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- Thesis schedule

Resultados

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table: Table caption

Resultados

Figure: Aquí iría una imagen de un lago

Conclusão

- more work
- more responsibility
- more satisfaction

Agradecimentos

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Referências I


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