Robô Autônomo para Coleta de Cubos

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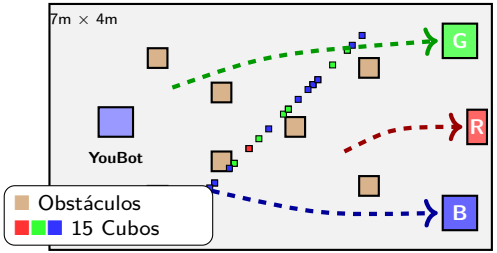
Agenda

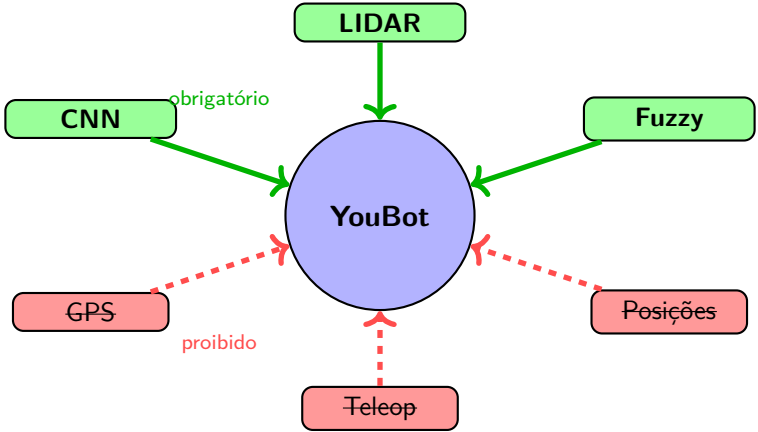

Problema
Perceporange!60cã
Fuzzy
A*
Demo
0–3min
3–6min
6–9min
9–12min
12–15min

O Problema

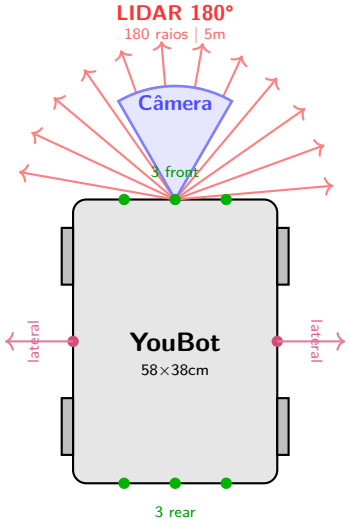


15 cubos $\rightarrow$ **3 caixas** por cor

Restrições


LIDAR
obrigatório
CNN
Fuzzy
YouBot
GPS
Posições
proibido
Teleop

Sensores do YouBot

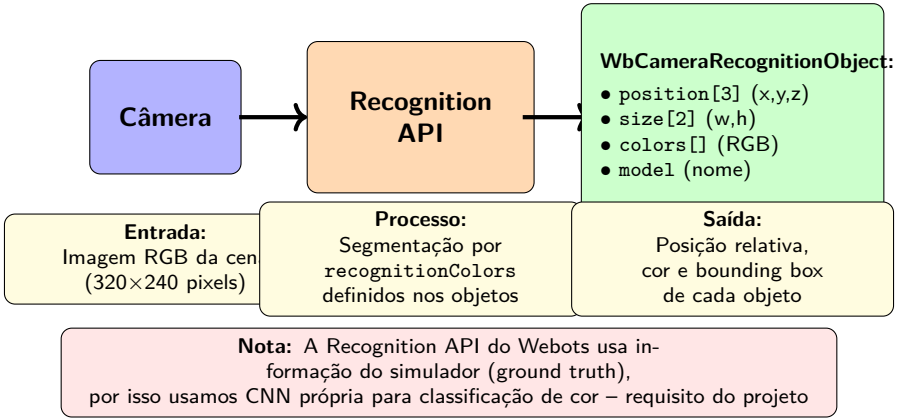


LIDAR
- 180 raios, FOV 180°
- Range: 0.1–5.0m
- Atualiza: 32Hz
- Constrói grade ocupação

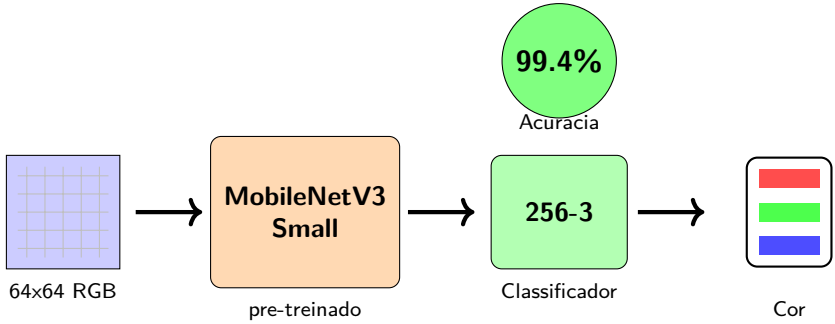
Câmera RGB
- 320×240 pixels
- Recognition API
- Entrada para CNN

Dist. Sensors
- 6 frontais/traseiros
- 2 laterais (novos)
- Range: 5cm–2m

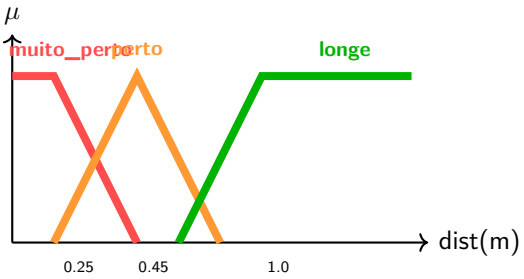
Recognition API do Webots



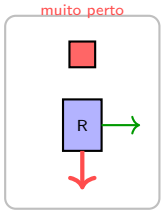
CNN – MobileNetV3



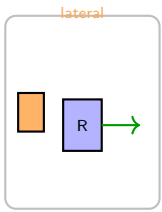
Lógica Fuzzy



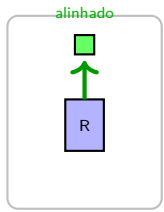
Regras Fuzzy



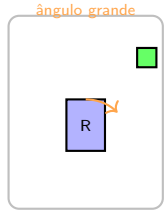
Ré + Strafe



Strafe



Avançar



Rotacionar

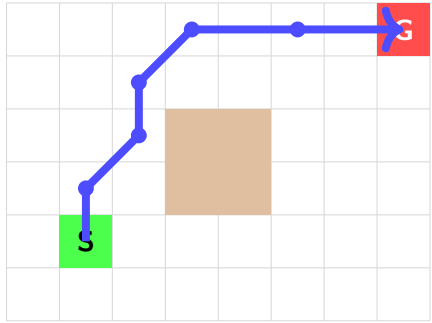
Algoritmo A*

$$f(n) = g(n) + h(n)$$

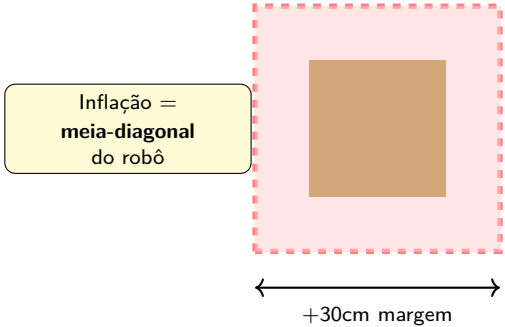
g = custo até aqui

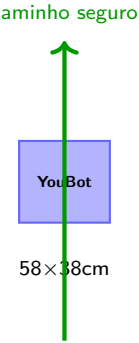
h = heurística

f = total

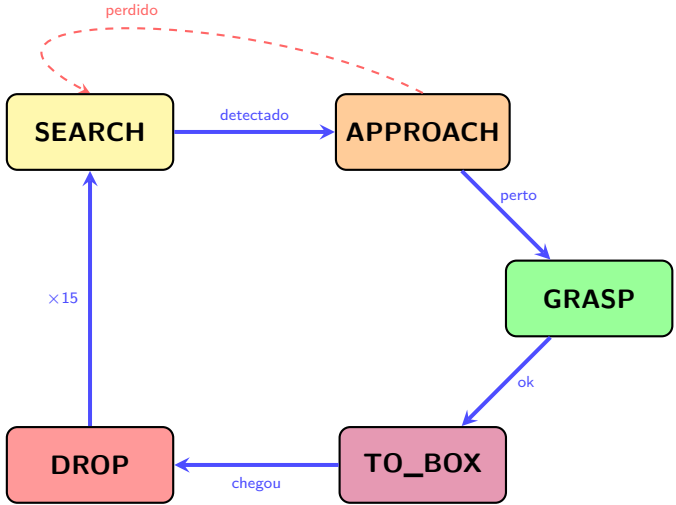


Inflação de Obstáculos

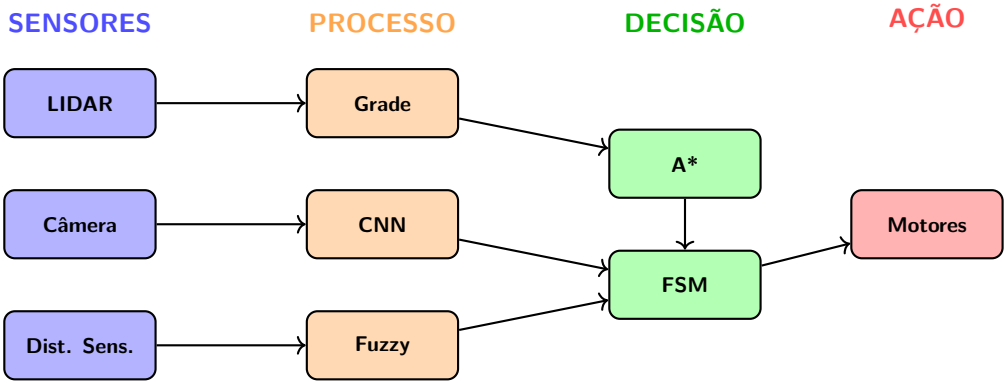




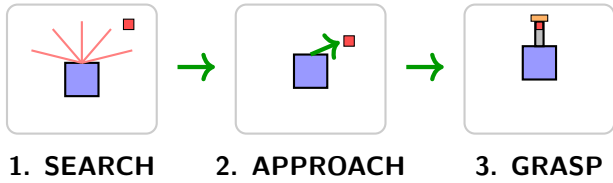
Máquina de Estados



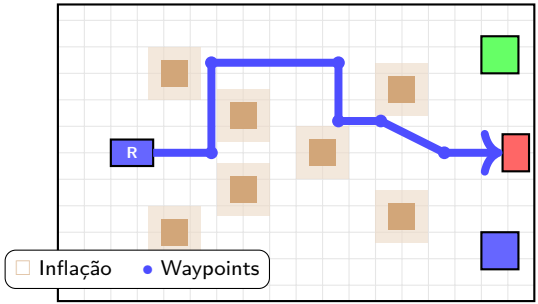
Pipeline Completo



Sequência de Coleta



Navegação A* em Ação



Demonstração

DEMO

Execução do robô coletando cubos

Webots Simulator

Limitações dos Algoritmos

A*

- Caminhos próximos a obstáculos
- Muitos nós redundantes
- Suavização limitada
- Lento em mapas grandes

Fuzzy

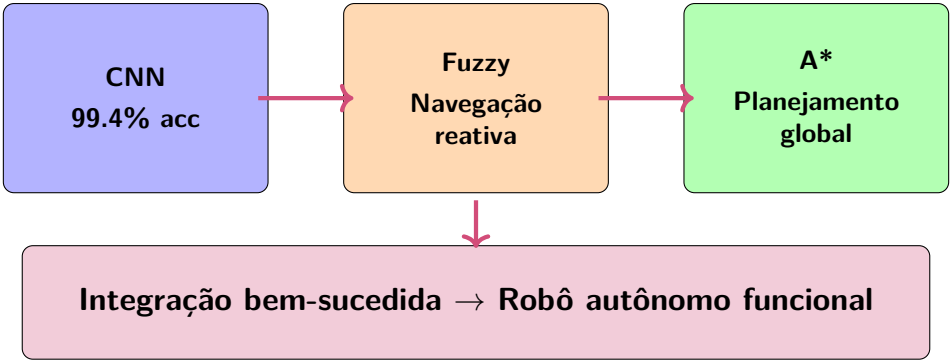
- Oscilações em navegação
- Mínimos locais
- Ponto cego $<$40cm
- Fraco em amb. dinâmicos

CNN

- Trade-off precisão/latência
- Sensível a iluminação
- Requer pré-processamento
- Fallback HSV necessário

Mitigações: Inflação de obstáculos (A*) | Sensores laterais + escape (Fuzzy) | HSV como fallback (CNN)

Conclusão


CNN
99.4% acc
Fuzzy
Navegação reativa
A*
Planejamento global
Integração bem-sucedida → Robô autônomo funcional

Obrigado!

Perguntas?

Referências Principais

Hart et al. (1968) – A*
Zadeh (1965) – Fuzzy Sets
Howard et al. (2019) – MobileNetV3