

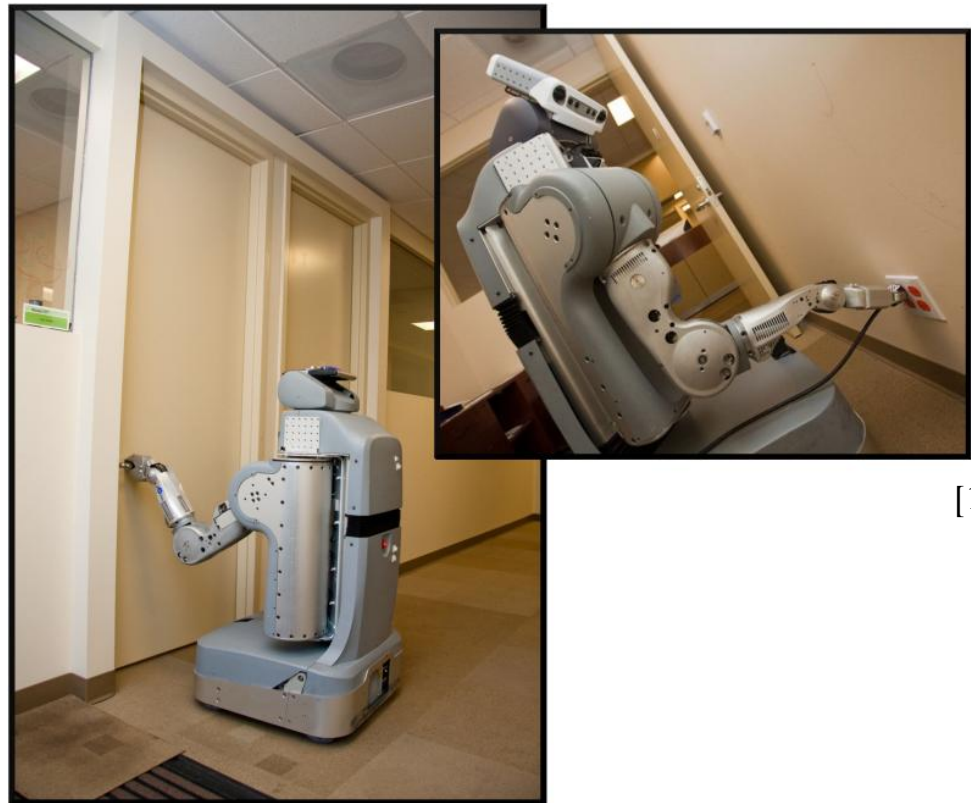
# Autonomous Door Opening and Plugging In with a Personal Robot

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# Motivation/ Objective

- Presents detection algorithms for doors, door handles , electrical sockets.
- autonomously navigate doors and plugging in to power supply.

- Implementing these algorithms on the PR2 robot



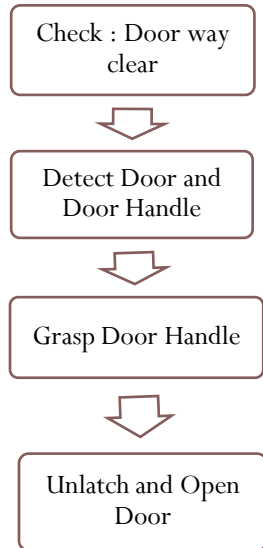
# Technical Approach

## Major sensing Elements :

- Laser Sensor
- Image sensor

## Door Opening :

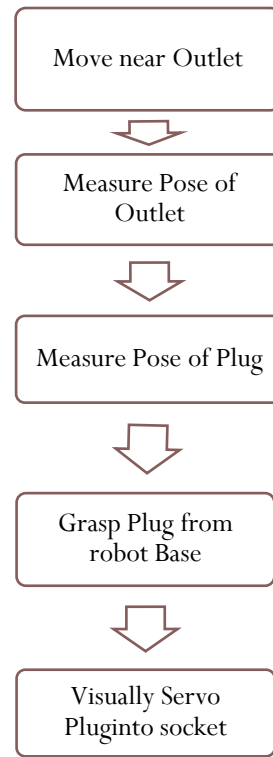
- Door Detection : point cloud data
- Handle Detection : Using Laser and Vision systems
- Door Opening



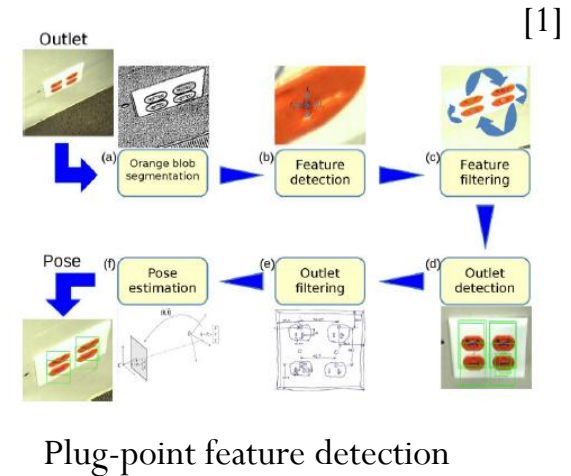
High Level state diagram for door opening task

## Plugging-in :

- Far field outlet detection
- Near field outlet detection
- Grasping and localizing Gripper
- Plugging in



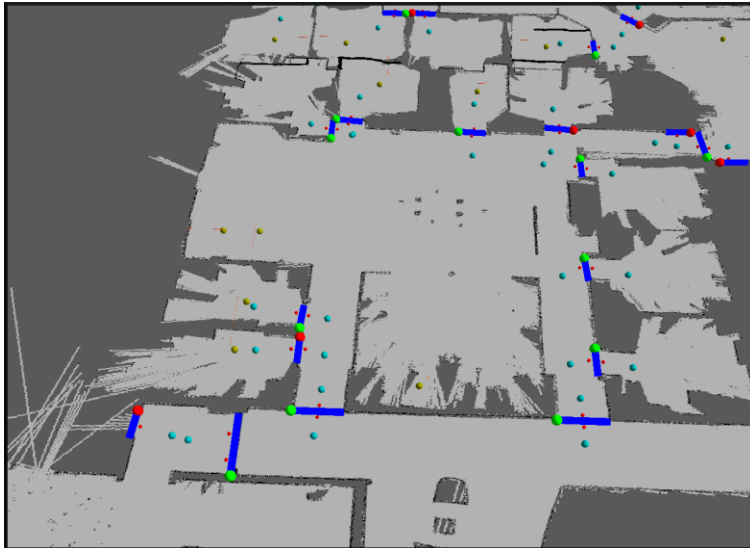
High Level state diagram for Plugging in task



# Results

1. Handle Detection : 100 % success
2. Far field outlet detection : 84 %
3. Near field Outlet detection : 100%
4. Detection of Plug : 100%
5. Grasping Plug: 91%
6. Plugging-in :95 %

[1]



A 3D map of the workspace the robot navigated in

Results from two completely independent test runs

[1]

Trial 1: 10 outlet goals, 1 behind locked door, 1 behind open door						
Trial 2: 9 outlet goals, 3 behind locked doors, 1 behind open door						
	success		abort		preempt	
Door Actions	T1	T2	T1	T2	T1	T2
detect door	9	8	5	0	0	0
detect handle	4	5	3	3	0	0
grasp handle	4	5	0	0	0	0
unlatch handle	3	3	0	0	0	0
open door	0	0	0	0	3	3
release handle	4	4	0	0	0	0
touch door	5	5	0	0	0	0
push door	0	0	0	0	5	5
Plug Actions						
detect outlet coarse	11	20	0	0	0	0
detect outlet fine	11	7	0	0	0	0
detect plug on base	11	7	0	0	0	0
grasp plug	9	7	2	0	0	0
localize plug	9	7	0	0	0	0
plug in	9	6	0	0	0	1
unplug	9	6	0	0	0	0
stow plug	9	6	0	0	0	0
Navigation Actions						
move base	75	86	4	23	0	0
check doorway	26	20	0	0	0	0

# Conclusion

- Initial runs had higher % of errors, but when used for re-learning produced almost always 100% results
- Test runs on the PR2 robot show the robustness of the algorithms for the general tasks

# Contribution to the Field

- These general higher level algorithms can be used for different kinds of robots for autonomous living
- Opens the field of using robots to perform daily life activities – away from labs and workstations.