# SemNav: How Rich Semantic Knowledge Can Guide Robot Navigation In Indoor Spaces

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**Abstract.** We have developed an ontological representation SemNav, specific to indoor spaces and service robots related to navigation and target finding task. The same has been tested on real life settings. This paper positions semantic web technology as one of the key elements of decision making in robotic tasks like navigation and object finding.

**Keywords:** Ontology, Cognitive Robotics, Semantic Robot Navigation

## 1 Background

A major challenge in robotics is successful execution of complex tasks by a robot in dynamic and uncertain environments. As an example, it is difficult for the robot to find objects that are either partially observable or out of sight, or not where it was expected to be found. Knowledge of the robot, objects and environment with rich semantic relations aids in such scenarios. Approaches presented in related works [1] and [2] are enhanced and adapted for this problem.

## 2 SemNav Ontology

SemNav was created by listing down relevant competency questions specific to the navigation and object finding problem. Initially starting with seed ontology of relations, images scenes [3] were processed to extract objects and captions in order to derive semantic relations. The same were aligned with WordNet to resolve ambiguity. Some of the prominent object relations are enlisted below:
(1) Occlusion: a bigger object can occlude a smaller object (like cup and jug)
(2) Co-location: two objects are in close proximity (like water glass and jug)
(3) RCC-8 classes: region connection calculus based qualitative spatial relations
(4) Location: object is usually located at specific zones (like pillow in bedroom)
(5) Disjoint: two objects do not co-occur together in a scene (like jug and towel)
(6) Dimension: range of length, width, height of objects (mobile phones, remote)
(7) Shape: objects can be abstracted to forms (like TV, window as rectangles)
(8) Color and texture similarity - indistinguishable objects (wooden furniture)
(9) Attribute relations from SPARQL endpoints (DBpedia) and commonsense ontologies: objects' shared resources (like electricity), inter-dependence, use, etc.
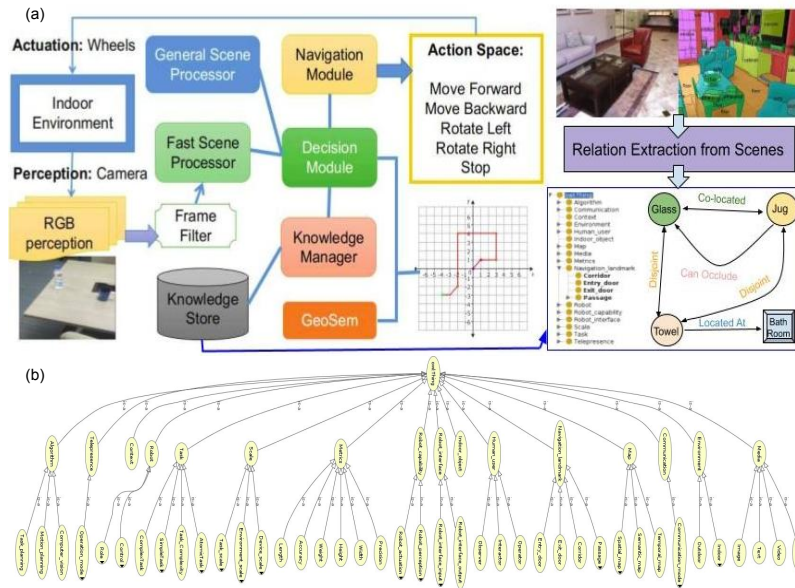
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**Fig. 1.** a) System using SemNav for robotic tasks b) OWL snapshot of SemNav

## 3    Semantic Navigation

Once the SemNav ontology (Fig. 1.a) is populated with relations and instance data (RDF) from parsing scenes, and human validated across some random samples, the knowledge base for semantic navigation (Fig. 1.b) is ready. The robot processes current scene using computer vision techniques. Obstacles and free spaces are understood from scene processing. Based on the goal given (like find an object 'cup'), the decision module consults the knowledge store; and matches it with current and past history of scenes with reference to GeoSem Map (a geocentric navigation map storing object instances and their instance relations). The semantic decision module instructs the Navigation module to derive a plan for navigation to the next spot (having highest probability to reach target goal) which in turn instructs the robot's motor wheels to move in that direction. The knowledge store's relation weights are updated by exploration.

## References

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