Mobile robot programming using natural language

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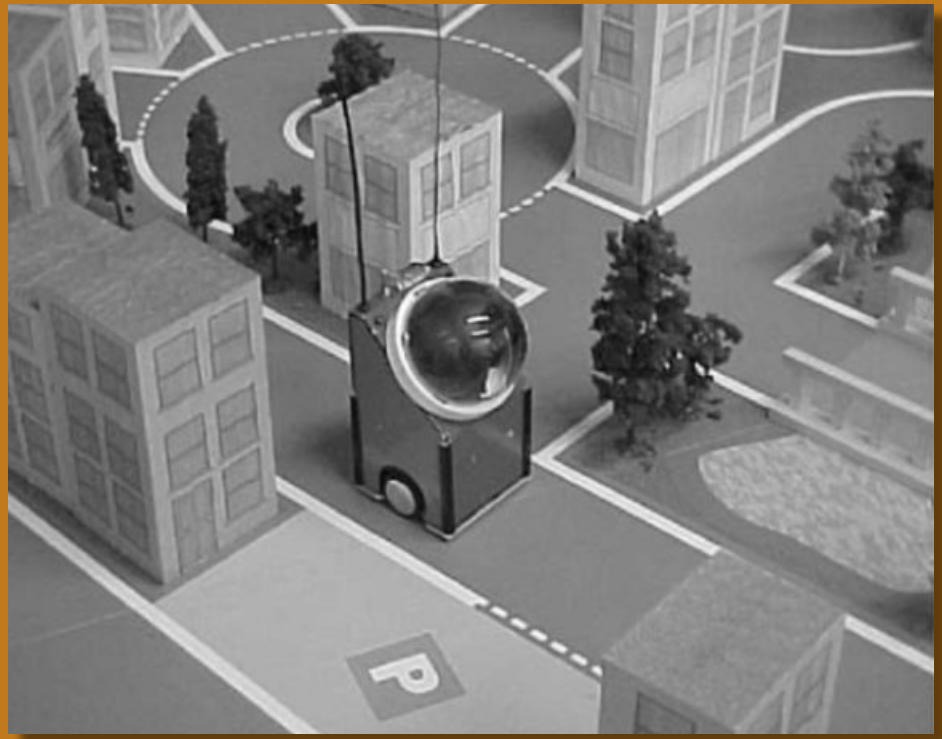
Setup & specifications

Robot

Environment

Onboard software



Definitions

Chunking = division of tasks into subtasks (chunks)

Sequencing = chunk-primitive correspondence, update knowledge graph

Repair = handles user error, underspecification, learning

Corpus = collection of command primitives between natural language and computer language

Discourse Representation Structure (DRS) = knowledge graph

Action, Symbol = procedure, identifier

Route instructions corpus

	Count	Primitive procedures
1	308	MOVE FORWARD UNTIL [(past | over | across) <landmark>] | [(half_way_of | end_of) street] | [after <number><landmark> [left | right]] | [road_bend]
2	183	TAKE THE [<number>] turn [(left | right)] | [(before | after | at) <landmark>]
3	147	<landmark> IS LOCATED [left | right | ahead] | [(at | next_to | left_of | right_of | in_front_of | past | behind | on | opposite | near) <landmark>] | [(half_way_of | end_of | beginning_of | across) street] | [between <landmark> and <landmark>] | [on <number> turning (left | right)]
4	62	GO (before | after | to) <landmark>
5	49	GO ROUND ROUNDABOUT [left | right] | [(after | before | at) <landmark>]
6	42	TAKE THE <number> EXIT [(before | after | at) <landmark>]
7	12	FOLLOW KNOWN ROUTE TO <landmark> UNTIL (before | after | at) <landmark>
8	4	TAKE ROADBEND (left | right)
9	4	STATIONARY TURN [left | right | around] | [at | from <landmark>]
10	2	CROSS ROAD
11	2	TAKE THE ROAD in_front
12	2	GO ROUND <landmark> TO [front | back | left_side | right_side]
13	1	PARK AT <location>
14	1	EXIT [car_park | park]

Program architecture

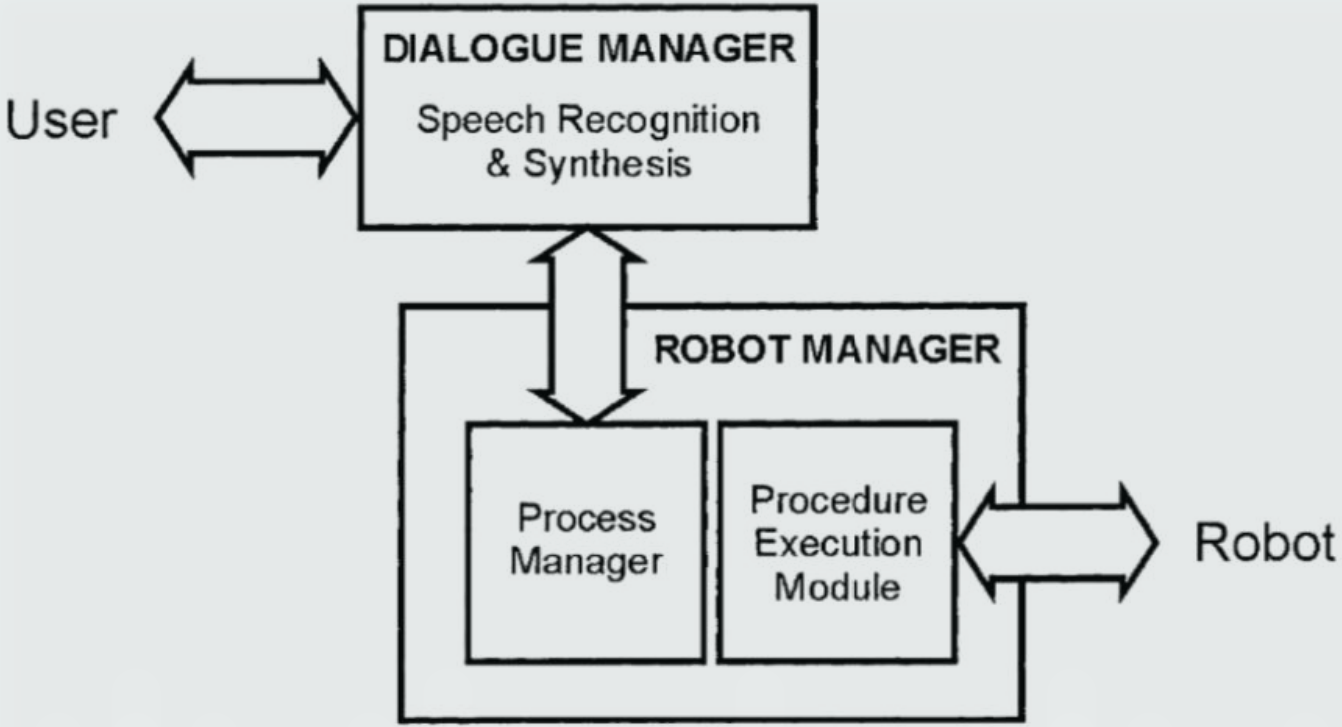
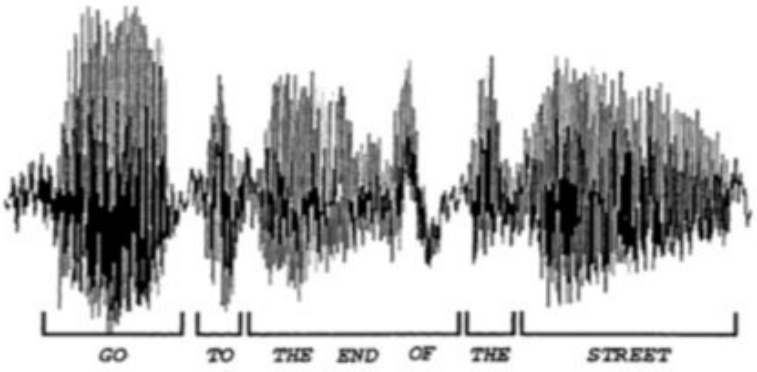
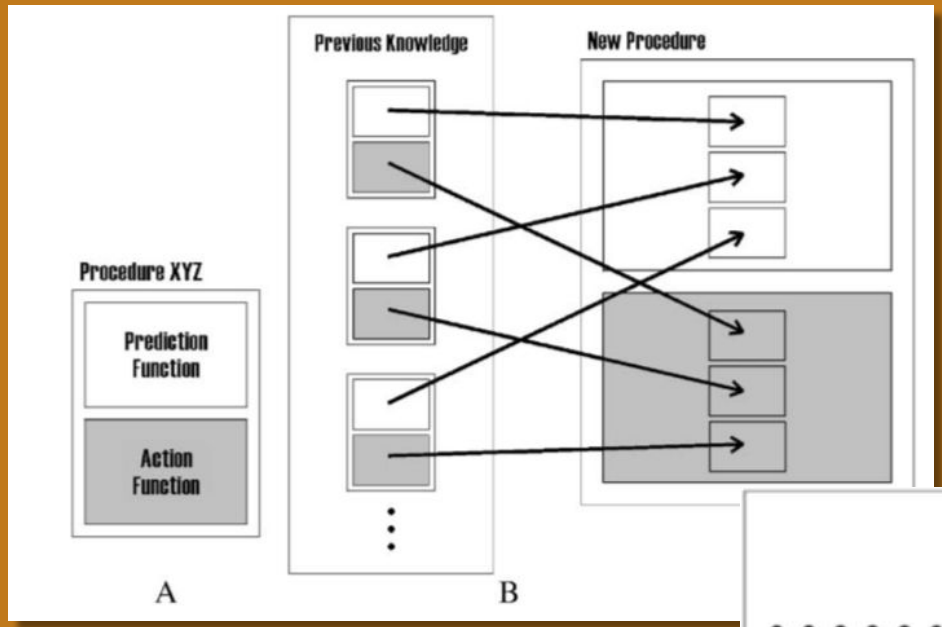


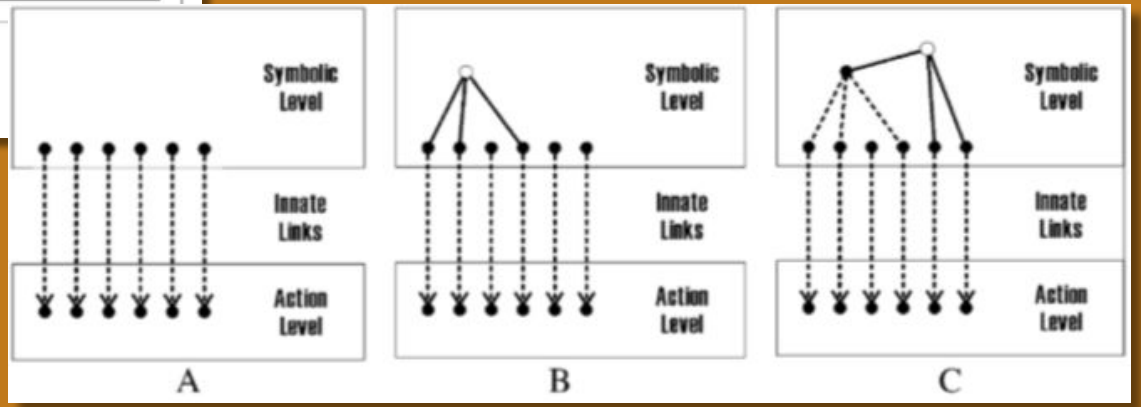
Fig. 4. IBL system's architecture (see text for description).

Natural language processing

Analysis			Repair
↓	Speech recognition		↑
↓	Tagging	**Go**/VB **to**/TO **the**/DT **end**/NN **of**/IN **the**/DT **street**/NN	↑
↓	Syntactic Parsing	[VG go] [to to] [NG the end of the street]	↑
↓	Semantic Analysis	Robot (x), end_of_street (y), request_go (x, y)	↑
↓	Functional Mapping	Goto("end_of_street")	↑
	Robot program	Until found(end_of_street) follow_the_road()	

Instruction-Based Learning (IBL)





Conclusions

Complexity of primitives can vary widely

Corpus vocabulary is not closed → new command primitives need to be defined

Learning is done at the symbolic level → requires fairly comprehensive corpus, route can be validated prior to execution

Testing results not included → difficult to judge validity, opens the to further research