

## Plug-and-Run Service Robot *HERMES*

**Story:** A service robot, *HERMES*, has arrived at the house of its new owner (actually, Rainer Bischoff, the “father” of *HERMES*). When it is switched on for the first time it knows nothing about the new environment where it is supposed to work from now on and about its new owners. The video shows how *HERMES* through dialogues and by other ways of learning builds up knowledge about the environment and the persons who live there. In the process it displays some of its skills and behaviors and eventually it is able to deliver useful services.

A key point is that, due to its intelligence (situation awareness, learning ability, communicative skills etc.), introducing *HERMES* into a new environment requires only a short time and no expert knowledge.

**General Comments:** From the beginning *HERMES* has some basic and universally applicable knowledge that it has received “in the factory where it was produced”, such as

- ▶ grammar and vocabulary of English, French and German
- ▶ common names of people (Rainer, Ines, ...), no spelling necessary
- ▶ common place names (office, room, corridor, door, kitchen, ...)
- ▶ common city names (Munich, Paderborn, ...)
- ▶ facts about, and relationships between, common places and objects (water should be found in kitchens)
- ▶ common knowledge about services (water can be carried in a bottle or a glass)
- ▶ rooms in houses are connected by corridors, a house usually has a kitchen
- ▶ In the video the robot extends its knowledge base through dialogues, e.g., by learning personal and place names and how to associate people to rooms or objects. Also shown is another form of learning, the building of an attributed topological map by autonomous exploration.
- ▶ To make communication less tiring and more natural the robot issues randomized answers, e.g., different words for saying “understood” -> “acknowledged”, “O.K.”
- ▶ The level of verbosity is adapted automatically to the perceived level of experience of the human partner: “What else can I do for you?” and longer explanations of offered services etc. should only appear if the user does not know what to do with the robot. (For demonstration purposes, in the video a high level of verbosity is active throughout and the robot comments almost every one of its actions, e.g., “Follow baseline successfully finished”.)
- ▶ Two methods of calibration-free navigation are shown:
  - ▶ “baseline following”: moving parallel to one, or both, visible base boards (where the wall intersects the floor); gaps in the base boards are taken as hints to a possible door
  - ▶ “wandering around”: following the outline of an obstacle or a corner in a constant lateral distance

Nothing in this video has been faked. The environment (office area of the museum HNF) has not been modified and all of *HERMES*’ actions are autonomous and sensor-controlled. In preparing the script, care has been taken, though, to avoid letting the robot run into situations that would exceed its sensory, cognitive or action abilities.

Start (film)	Start (file)	
	0:00	Lead in
	0:08	Initial dialogue; the robot learns its new master’s and its own name etc., introduces itself and offers its services. It is ordered to explore the environment on its own for 3 hours.

	1:40	<i>HERMES</i> explores its new environment and builds an attributed topological map. The robot does not (cannot) open doors. It knows, however, that always a room exists behind each closed door. Therefore, it enters a symbol for a not yet explored area behind each door in the map. Also it knows that all corners between corridors have angles of 22.5°, 45°, 90° etc.; this allows it to draw a nice-looking map without having an accurate navigation system. For our maps and navigation methods geometric accuracy is actually not important, though.
	2:50	Suddenly <i>HERMES</i> meets another person, Ines, and interrupts the execution of the exploration task. She asks for some information and requests <i>HERMES</i> to get some water in the kitchen and deliver it to her office. Through the dialogue <i>HERMES</i> learns Ines' name, the locations of her office and the kitchen and associates in its data base Ines with her office.
	4:17	<i>HERMES</i> goes to the kitchen and simultaneously continues the map building.
	5:00	<i>HERMES</i> arrives at the kitchen. Fortunately Costel happens to be there. He is cooperative and gives <i>HERMES</i> a glass of water. The robot uses its kinesthetic sense in accepting and giving objects.
	5:55	<i>HERMES</i> leaves the kitchen for Ines' office, avoids some obstacles and continues the map building.
	7:25	<i>HERMES</i> arrives at Ines' office and offers the water to her. Also, it gets some information for her from the WWW by using its wireless LAN connection.
	8:36	<i>HERMES</i> continues its autonomous exploration and map building. (Not shown: <i>HERMES</i> occasionally asks people for the names of places, such as the library, and enters those names into its map.)
	10:00	After 3 hours <i>HERMES</i> returns to the starting point by using its new map.
	10:25	Rainer requests a book to be taken to the library. Since it is too large to be held by the robot's grippers, Rainer places it on <i>HERMES</i> ' back.
	11:10	On the way to the library <i>HERMES</i> meets people who request information in German, French and English. <i>HERMES</i> replies in the language chosen by each human. Gestures with head and arm make the communication more effective and natural, e.g., when giving directions to Ines' office.
	12:51	Lead out