Robotic Home Assistant Care-O-bot II

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Abstract - **Technical aids allow elderly and handicapped people to live independent and supported in their private homes as long as they wish. As a contribution to these required technological solutions, a demonstrator platform for a mobile home care system – called Care-O-bot – was designed and implemented by Fraunhofer IPA, Stuttgart. Care-O-bot is a mobile service robot which has the capability to perform fetch and carry and various other supporting tasks in home environments. Strong emphasis is also laid on integrating communicational and social features, like video telephone, automatic emergency calls and other interactive communication.**

Keywords - **Robotic Home Assistant, Service Robot, Care-O-bot, Household Tasks, Intelligent Mobility Aid.**

I. PRESENT SITUATION

To improve and to ensure the quality of life for the elderly and disabled is an essential task of our society. Out of 82 million people living in Germany today, according to numbers of the Federal Statistical Office, around 22 percent are seniors above 60 years. With the demographic development continuing, in ten years the number of people above 60 years old will comprise one quarter, in the year 2040 even 36 percent of Germany's population. In an equivalent way, the number of people limited by diseases or handicaps will rise.

Technical aids enable people in need of support and care to live independently in their accustomed home environments for a longer time. This not only fulfils their desire for independence and autonomy, it also helps avoid the high costs for the individual treatment in nursing homes that might otherwise be necessary. This, in turn, results in immense savings for the government as well as for each individual.

II. FUNCTIONALITIES OF A ROBOTIC HOME ASSISTANT

Technical aids provide support and instructional help in a person's daily life and also promote self-initiative. Therefore, a robotic home assistant would need to perform the following tasks:

A. Household Tasks (Fig. 1)

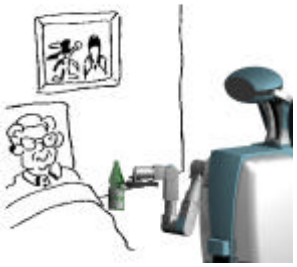

Fig. 1. Care-O-bot serving a bottle of water to the bedridden user.

- Execute everyday jobs as serving drinks, setting the table, operating the microwave, simple cleaning tasks.
- Fetch and carry objects as e.g. books, medicine.
- Support in grasping, holding, and lifting objects.
- Control of the technical home infrastructure as e.g. heating system, air conditioning, lights, windows, doors, alarm system, etc.

B. Mobility Aid (Fig. 2)

Fig. 2. Care-O-bot being used as an intelligent walking aid.

- Support for getting up from the bed or a chair.
- Intelligent walking aid.

C. Communication and Social Integration (Fig. 3)

Fig. 3. Communication Platform Care-O-bot.

- Media management (Videophone, TV, stereo, etc.).
- Day-Time-Manager (time for medicine etc.).
- Communication with medial and public facilities (physician, authorities, etc.).
- Supervision of vital signs and emergency call.

III. CARE-O-BOT

Care-O-bot is a mobile service robot designed to perform the tasks mentioned above. The first Care-O-bot prototype was built in 1998 [4]. Care-O-bot has already proven its ability to operate safely and reliably in public environments. Three robots based on the same hardware platform and control software have been installed in March 2000 for constant operation in the "Museum für Kommunikation Berlin" where they autonomously move among the visitors, communicate to and interact with them [5].

Care-O-bot II is equipped with a manipulator arm, adjustable walking supporters, a tilting sensor head, and a hand-held control panel. It was first presented at HANNOVER MESSE 2002 (Fig. 4).

Fig. 4. Care-O-bot II at HANNOVER MESSE 2002.

IV. Components and Abilities

A. Multimodal User Interface

Even users without any prior technical knowledge should be able to operate and use Care-O-bot without difficulties [1]. For simple man-machine communication without misunderstandings, multiple sensing channels (speech, haptics, gestures) should be addressed. Commanding the robot, for example, is done by speech input and by using the integrated touch screen. The necessary feedback about the robot system state is given by speech output and graphical presentations on the monitor.

B. Interactive Task Planner

Care-O-bot is equipped with a hybrid system architecture, containing deliberative and reactive components. The assistant can be instructed interactively through the user interface. Each user command is transferred to a symbolic planner which then generates a list of actions necessary to fulfil the given task. The robot control system executes these tasks consecutively using a previously learned world model provided in a database. The assistant's knowledge about its environment is updated continuously based on sensor readings. With the given system architecture, Care-O-bot is able to plan and execute complex tasks autonomously.

C. Control Software

The Care-O-bot control software is based on the "Robotics Toolbox", an extensive software library, which - in several independent packages – contains modules for implementing all necessary mobile robot control functions, as e.g. autonomous navigation, obstacle avoidance, sensor and actuator drivers etc. This software library, developed by Fraunhofer IPA, not only enables the development of complex robot control programs in extremely short time, it also facilitates the transfer of an existing programs to different hardware platforms and operating systems.

D. Manipulation

One of the assistant's most important skills is the ability to manipulate objects in its environment. A manipulator arm, developed specifically for mobile service robots, provides the possibility of handling typical objects in the home environment. The flexible gripper attached to the manipulator is suitable for grasping objects found typically in a household as e.g. mugs, plates, and bottles.

E. Walking Aid

The functionality of Care-O-bot as an intelligent walking aid provides an enormous enhancement in safety and comfort compared with conventional walking supporters. According to the user requirements, different autonomy levels of the mobile assistant can be selected [2].

Two basic operation modes have been implemented on the intelligent walking aid: "Direct Control Mode" enables the user to "push" the robot to a certain direction, whereas obstacles on the path are detected and surrounded. In "Target Mode" the user follows the assistant along a preplanned, optimal path to a previously specified target.

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References

[1] Graf, B., Hägele, M.: „Dependable Interaction with an Intelligent Home Care Robot". In Proceedings of ICRA-Workshop on Technical Challenge for Dependable Robots in Human Environments, 2001, pp. IV-2.

[2] Graf, B.: „Reactive Navigation of an Intelligent Robotic Walking Aid". In proceedings of ROMAN-2001, pp. 353-358.

[3] "MORPHA – Interaction, Communication, and Cooperation between Humans and Robot Assistants", http://www.morpha.de.

[4] Schraft, R.D.; Schaeffer, C.; May, T.: "The Concept of a System for Assisting Elderly or Disabled Persons in Home Environments", Proceedings of the 24th IEEE IECON, Vol. 4 Aachen (Germany), 1998.

[5] Schraft, R.D.; Graf, B.; Traub, A.; John, D.: „A Mobile Robot Platform for Assistance and Entertainment". In Industrial Robot Journal, Vol. 28, 2001, pp. 29-34.