Ever since the books of Asimov, humanoid robots have captured the imagination of millions of people around the world. Although the first industrial robot, Unimate, was put into service in 1961 by General Motors, the desired (but sometimes feared) future of humanoid robots having a place in everyday life is still far from reality. A team of twenty students is working on the development of personal robots to bring them from factories and laboratories into people’s homes.

There are myriad applications imaginable for personal robots. Aside from using robots to help with small tasks in and around the house, personal robots can be employed to aid in fields with more direct value to society, such as health care. Special service robots could, for example, help care for the elderly or take simple tasks out of the hands of expensive personnel, leaving much more time available for personal attention. Suggestions have also been made to employ these robots in hospitals where the visit of a doctor or specialist could be done remotely, without losing the human touch of direct communication.

The Delft Robotics Team takes up the challenge of producing a service robot that is affordable and therefore accessible to everyone. The team consist of approximately fifteen bachelor and master students from different faculties, including 3mE, EEMCS and Industrial Design. Since robotics is an inherently multidisciplinary domain, the personal and scientific interests of the team members span a wide array of fields, from robot vision and navigation to speech recognition and design. The team use state-of-the-art technology, combined with relatively cheap hardware to overcome the extra challenges that arise when moving a robot from the controlled environment of a laboratory or factory to the dynamically changing environment of a human household.

REAL LIFE CHALLENGES
One of the key challenges in the development of personal robots is having them move and behave autonomously. In space robotics, where communication with the base is very limited, the robot needs to be able to explore unknown and sometimes dynamic environments by itself, overcoming obstacles on its path and determining for example the best place to take rock samples. In a household or care facility, the amount and speed of communication is of course not as limited as in space robotics, but requiring too much input from the user would make a personal robot quite useless. Its strength lies precisely in the fact that it can be commanded by general tasks, while specifying as little as possible of the conditions in which the tasks need to be performed. Whether it is an objective like “Fetch me a drink” or “Search for interesting rock specimens”, the robot needs to be able to complete the tasks without prior information on
what the environment looks like or where exactly the needed objects can be found. Therefore, we have equipped our robot with a learning system that can create an environment map online and discover novel objects by exploration.

MAN AND MACHINE

One problem the team faces, which is not encountered in space robotics, is the interaction with humans. Since humans are even more unpredictable than the unknown, dynamic environments the robots move in, flexibility and safety become very important factors. The navigation system, for example, needs to deal with sudden moving obstacles, maintaining a safe distance at all times. The robots are also equipped with a patented gripper, developed by the Delft BioRobotics Lab. As opposed to most industrial grippers, where the exact positions of the digits are controlled, this gripper is force controlled. Combining a differential with a clever mechanical design, this three digit under-actuated gripper is able to grasp a wide array of objects with a constant force, regardless of the exact position of the digits. This not only ensures that objects of many different sizes and materials can be handled, making the robot very versatile, but also that it is safe for the robot to interact with children.

Interaction with humans, however, concerns more than just safety. If personal robots are to be accepted as an integral part of day-to-day life, the interaction needs to occur in a natural, human-like fashion. In order to achieve this, the team is working on speech recognition, natural language processing and speech synthesis. Using these techniques, a personal robot can be given commands in a way that is easy and natural for the user. Instead of failing to process unclear commands, the robot is able to ask for clarification or request missing information. This ensures that a user does not have to memorise a set of possible commands, but is able to control the robot by simply talking to it, the way two persons would interact. This not only makes controlling the robot very easy for the average user, but it also helps in feeling an emotional connection with the robot.

To further improve this sense of connection, other team members are working on face recognition. The personal robots are able to recognise people from a database of known faces as well as learn new faces. Besides adding another human touch to the interaction, this function will be very useful when employing service robots in health care facilities, making it possible to deliver personalised care to individuals. A robot could for example be used to deliver the right medication to the right patient, based solely on this face recognition.

The last item that needs to be considered when trying to have people embrace personal robots in their homes and lives is the design of the robot. While in industrial and space robotics, the design may not be given a high priority, the appearance of a personal robot is much more important. Therefore a small team of industrial designers is assigned to this task. In order to make the robot appear as unintimidating as possible, all mechanical and electrical parts are hidden by covers. Using naturally flowing lines and big doe-like eyes, the robot is made to look very friendly, so even children will like it. The name given to the robot, Robby, further enhances this friendly image. To see reactions of the general public to our design, we have attended different fairs such as ICT&Zorg where our robot received a very warm welcome and a large interest from people (Figure 1).

ROBOCUP®HOME COMPETITION

Robby, together with the Delft Robotics team, will participate in the Robocup® Home competition. This annual competition is part of the RoboCup initiative and is the biggest international competition for autonomous service robots. The robots are tested in a series of challenges in a realistic non-standardized home environment. These challenges include the “go-and-get-it task”, in which the robot needs to retrieve the correct drink upon request by a jury member, and the “follow-me task”, where the robot needs to be able to follow a person at a safe distance without losing him or her in a crowd of people. All these tests need to be performed autonomously, using only spoken commands. Also the appearance of the robot is judged and points can be deducted for an unappealing or even intimidating design.

Whether the competition will be won by Robby yet remains to be seen, but the team is confident and also see this as a great learning experience in the field of personal robotics. Many interesting topics are still open for research to further improve the performance of the robot and ensure the next generation will be even better. The predicted future where personal robots are all around may seem like a distant one, but the team is convinced that the first personal robots can find their way to people’s homes in the next ten years.

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