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## In Focus - March 2013

### Life quality with more "grip"



Lena Kredel enjoys the freedom and independence given by the assistant robot "Friend."  
Bild: IAT Bremen

03-01-2013 - Service robots are suitable for several fields of application. They can be used for defusing explosive devices, for milking cows, or for mopping floors. According to many experts in the field, they will be used in the professional area more and more frequently as an assisting robot for humans - for industrial applications as well as also for care and rehabilitation.

Lena Kredel suffers from multiple sclerosis. She cannot move her arms and legs, but nevertheless she is working. The literary scholar originates from Bad Segeberg, and does an apprenticeship as Librarian at the University of Bremen. The particularity: She is using the service robot "Friend" as a tool, and its lightweight arm allows autonomous environmental interaction. Now the robot specialists from the Institute for Automation Technology (IAT) Bremen have modified the mechatronic helper so that Lena Kredel can independently catalog the books in the university's library.



Project Manager Torsten Heyer during a system test.

"Friend is a stroke of luck for me," said Lena Kredel. The abbreviation "Friend" stands for "functional robot arm with user-friendly interface for disabled people". - This sounds a little bit lengthy, and at the first glance it also looks a little bit bulky: The electrically powered wheelchair is equipped with a monitor, all sorts of sensor systems, and a lightweight arm from SCHUNK. With a joystick at her head and via voice recognition, Lena Kredel controls her assisting robot, records books in a standard software for libraries, and uses a normal internet browser for research. In the course of time "Friend" really became a kind of friend for her. Using "Friend" has brought her a lot of pleasure, and it is obvious that Lena enjoys the attained freedom and independence.



LWA

### Human and robot are working hand in hand

Since 1997, the IAT Bremen has conducted research on robot-supported assisting systems. Today, the solution which is used by Lena Kredel is the fourth generation. The system is based on a concept of shared autonomy. Things which can be independently solved by the robot, are done by the robot itself. If it reaches its limits, the user intervenes for correcting the gripping position, or if unforeseen disturbances occur. According to Torsten Heyer, project manager at IAT, presently about 95% of all processes can be solved this way without any external help. For ensuring perfect teamwork, the environmental conditions are autonomously recorded via a three-dimensional camera and an infrared camera which are positioned over the head of the user. When Lena Kredel starts the system, the camera locates the bookshelf, the books, and the storage position automatically. Then the lightweight arm approaches the determined position autonomously. Markers and colored markings are used by the system as a point of reference. The control of the whole gripping system is carried out by Lena Kredel. For this purpose, the system has been equipped with numerous features, which allow assessment and control of the gripping process. A camera at the robot gripper continuously transmits live pictures of the gripping process, which are immediately visible for the user on a monitor. At the same time the camera can be used as a reading lens which makes even small print readable. If the system should approach its limits, Lena Kredel intervenes.



The key element of the mobile robot is a lightweight arm from SCHUNK. For being able to grip books, a mechatronic parallel gripper from SCHUNK is used.



Control Unit

### Versatile lightweight arm

The central element of the assisting robot is a gripping arm in modular design with seven degrees of freedom, whereby three are used for orientation, three for positioning, and one for bypassing obstacles. In contrast to classic industrial robots, the lightweight arms are designed for automating changing works in the direct environment of a human. These include inspection and assembly tasks, and also the use of assistance systems. A permanently high repeatability of +/- 0.1 mm ensures optimum preconditions for precise gripping operations. It is portable, or designed for mobile utilization. The maximum payload amounts to 10 kg. At a battery-servable power supply of 24 V, the average power requirement is below 3 A. If no socket should be available, or if the system is used completely mobile, the assistance robot may be self-sufficiently operated by the standard wheelchair battery for about two to three hours. Since the power consumption of the gripping arm is below 100 W, the risk of injury of the standard version is very low. In order to exclude even this risk, the IAT Bremen additionally equips the assistance robots with force-moment sensors and sensors for spacial monitoring. Since the drive amplifier and controller are directly integrated in the lightweight arm, the system does not require a control cabinet. The complete control and regulation electronics are integrated in the joint drive. Position, speed, and torque can be flexibly adjusted. Due to the integrated intelligence, universal communication interfaces and cable technology for data transmission and power supply, the arm can be quickly and easily integrated into existing concepts. Moreover, it is controlled via an embedded personal computer. Due to the light, rigid design it works particularly energy-efficiently. This pays off in terms of long run-times during mobile applications.



The partial autonomous system is controlled by the user during the gripping process.



Control unit



Control unit

### Assisting systems can be operated by amateurs, too

The lightweight arm is programmed via a suitable interface. The motion planning is set up on it and is transferred to the interface. The individual movement strategies were developed by IAT. According to Christos Fragkopoulos, employee at IAT, programming of the lightweight arm has been easy. "We control the speed or current via the interface. How the modules are working with each other depends on the individual program. This belongs to the scientific work which has been carried out by IAT," said Fragkopoulos. Since the system is based on a modular design, and each component has been individually programmed, individual modules can be used quickly and easily on request. For enabling robotics amateurs the operation of assisting systems, the IAT has developed with the support of Lena Kredel an understandable user interface for controlling the lightweight arm.

The results are impressive: At the beginning, the pure handling time for an individual book has been about 17 minutes, now Lena Kredel requires between five and seven minutes for handling, and for cataloging about 15 minutes. In the next step reliability of the system shall be further increased. The aim is to achieve a success rate of 99.9% over the course of time. According to Torsten Heyer, the model project "ReIntegraRob," sponsored by the Integration Office in Bremen with 400.000 Euro, shows the hidden potentials of assisting robots. "After an integration and orientation phase, users can work full-time in the ideal case without requiring a personal assistant."

### "I am proud of being able to work independently"

#### Lena Kredel speaks about the possibilities and the limits of assistance systems



Lena Kredel: "I regard it as an enrichment since I can do something worthwhile again."  
Bild: IAT Bremen

#### Frau Kredel is working with the assisting robot Friend for over a year. How quickly did you familiarize yourself with your mechatronic helper?

Lena Kredel: At the beginning I had respect of this monster. When I started to train with the system I said to my assistants, "I have to go into the robot again today." Then I gradually learned to deal with "Friend," and quickly recognized the advantages. Later when I have been able to maneuver the vehicle unerringly with the joystick, my concerns disappeared.

#### Did you have experience with electric wheelchairs before?

I always had the feeling that electric wheelchairs are too obtrusive. However, I quickly familiarized with "Friend," even though it is so bulky.

#### What is your benefit?

The system enables me to participate in the working life again. I have my job in the library, and I make a contribution in optimizing this robot.

#### How did your friends react when they heard that you are going to work again?

The reactions were very different. Some didn't understand me why I would expose myself to the work burden since I am handicapped. For me it is an enrichment doing something useful, and I am proud of being able to work independently.

#### Could you imagine that a service robot may replace your assistants one day?

I am skeptical since my apartment is too small for such a system, and since my social and personal contacts are very important to me.

#### Are there any situations where you would wish to have such an electronic helper?

In case of personal matters, the technology can be very valuable help. I am already using technical solutions for writing letters or for making a phone call. They make me independent. But I can also imagine such an assistance system for eating.

#### Why using it for eating?

People are eating in a different way. This can always lead to unpleasant situations during feeding. Here a robot may help. The IAT institute has already developed first concepts in this field of application with "Friend."

Thank you for this conversation Ms. Kredel.

2013-03

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2013-02

#### Manual work - made by robots

Assembling, deburring, polishing - complex tasks can now be undertaken by robots, which traditionally were manually done in the past. In this connection, technologically advanced robot accessories play an important role.

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2013-01

#### **In the interplay between precision, flexibility and economy**

Users who want to benefit from the possibilities of integrated CAD/CAM solutions, highly dynamic 5-axis machines, and efficient cutting material in the mold making industry, should also consider its toolholding systems, which have become to a decisive success factor, if the balancing act between precision, flexibility, and efficiency should succeed.

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