

## Robot spotting at the World Expo 2005

Bram Vanderborgh and Björn Verrelst of the Robotics and MultiBody Mechanics Research Group of the Vrije Universiteit Brussel and BJA members travelled to the EXPO 2005 in Japan. Driven by their profound interest in new emerging technologies concerning novel robotic applications, they went to visit the prototype robot exhibition in June this year. This journey really convinced both that research connections between Belgium and Japan in the field of personal robots should be more elaborate.

### New Emerging Direction in the Field of Robotics

If one fantasises about robots, generally one will start to contemplate on the astonishing robots which appear in many science-fiction movies, and this already for decades, clearly showing mankind's interest for automated machines and robots. In reality these robots, with all their imagined skills, do not exist yet. In fact most realistic and generally known robots are found in industrial environments such as car assembly plants, where cars are nearly created only by robotic arms, without human intervention on the floor. However, these robots are dangerous and as such safely kept away to avoid any human-robot collision during operation. And they are far from similar to the robots interacting with humans presented in science-fiction movies.

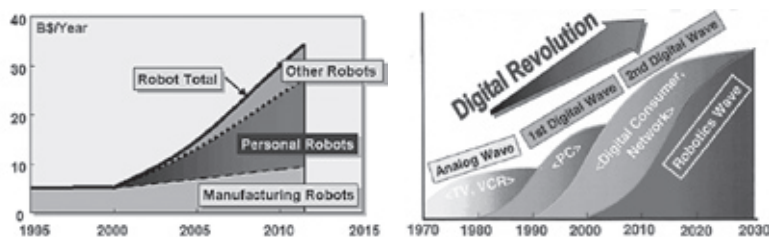
Nowadays robots are being developed which will act in the immediate environment of humans. The best known examples are the automatic lawn mower and in-house vacuum cleaners for domestic purposes and a large number of entertainment robots such as Aibo and Robosapiens. Although we are at the beginning of this newly evolving robotics area, there are already a number of astonishing robots. Unfortunately large-scale production of these systems is not yet for tomorrow, due to essential technological shortcomings in the field of perception, artificial intelligence, etc... as such that practical applications are not widespread available. But the fast evolving technological evolution together

with the rapidly increasing interest in these new robotic applications, show that a promising future lies ahead for the new robot of tomorrow. Predictions of the Japan Robot Society state that the market of robots by the year 2010 will reach a turnover of about \$ 35 billion each year, a sales number which exceeds the current Japanese PC market.

Japan is definitely the leading country concerning research and development of these new robotic applications. Not only exists a large financial support of the Japanese government for research in this robotics field but many big Japanese companies such as Honda, Sony, and Toyota have their own specific large-scale research and development projects. Both incentives create of course an interesting development environment which is not present on the same scale in Europe. Here some specific EU funded projects and robotic networks such as the EURON and CLAWAR network exist, and some individual countries such as Italy, France and Germany have more elaborate research and development teams working on new robotic applications for example in the medical field.

In Belgium on the other hand only a poor research and development climate exist concerning new applications on personal robots et al. Some scattered projects are being conducted at university level but there is no actual policy which directs research activity in this new emerging field.

This is one of the major concerns of the Robotics and MultiBody Mechanics Research Group of the Vrije Universiteit Brussel, who is resolutely trying to consolidate a multi-disciplinary research environment focussing on new robotic applications in which human interaction is one of the key elements. Hereby driven by the conviction that indeed a huge economic market will open itself in the nearby future, and missing this opportunity would be a strategic blunder. The Robotics and MultiBody Mechanics research group has already some specific experience in the field of robotics (see frame 'Robots at the Vrije Universiteit Brussel') and has recently started the ANTY project (see frame 'ANTY a Child Friendly Cuddle Robot') in which the group is trying to gather a multidisciplinary research environment around the topic of personal robotics. And in the conviction of the strength of 'jointed expertise' the group is also focused on consolidating international collaboration on European level, but also with Japan. The first initiative in this context is taken by Björn Verrelst who will be conducting research for one year in a distinguished Japanese robotics laboratory (see frame 'Belgian Robot Researcher in Japan').



Predictions of the Japan Robot Society concerning the future market of personal robots. (Source: Summary Report on Technology Strategy for Creating a "Robot Society" in the 21<sup>st</sup> Century, Japan Robot Society)

## Robots at EXPO 2005 in AICHI

As already pointed out, Japan is currently the leading country in the development of all kinds of new robotic applications. This could be clearly witnessed at the EXPO 2005 in AICHI, during which the robot prototype week (June 2005) 65 robot prototypes were exhibited besides the 'regular' robots which populated the EXPO all the time.

Ir. Bram Vanderborght and Ir. Björn Verrelst of the Robotics and MultiBody Mechanics Research Group and members of BJA, went to Japan AICHI where they literally bivouacked in the robot prototype pavilion for nearly 10 days. A glimpse of what was exhibited:

One of the most astonishing robots were displayed by Toyota, which were presented in a spectacular show of about 30 minutes in the Toyota Pavilion. Here the spectator could enjoy a show with the humanoid robotics concert group 'CONCERO' which opened the show and consisted of three humanoid robots playing the trumpet, accompanied by other type of robots playing the tuba, French horn and a drumming robot. Their fingers work the instrument's valves, and the robots have mechanical lungs and artificial lips. All mastered by a DJ robot. The show ended with the appearance of Toyota's I-foot, which is a two-legged mountable walking chair transporting a single person, a view of Toyota on new types of mobility for the future.



Humanoid robotics concert group 'CONCERO' and I-foot of Toyota Motor Corporation.



At the entrance of the EXPO visitors could consult a charming reception robot, which responds in four languages to questions concerning the EXPO. A 'Virtual Sister' of the receptionist was presented in the robot prototype pavilion of which the robot appearance mimics a famous Japanese television presenter. This robot is used for research concerning human communication and interaction with android robots. In robot station itself one could admire the third sister, which is really a vamp amongst robots and beyond. She introduced the several different robot shows at the robot station in joint interaction with a real human presenter.

At the permanent robot show in 'Robot Station', young and old could enjoy the wonders of the robotics world. One could look in detail at several partner robots assisting on the field at the world EXPO with cleaning, surveillance and collecting garbage. NEC presented their childcare robots 'Papero' to entertain



Reception robot answering questions in four languages; Replica robot of a famous Japanese television presenter; Miss Robot introducing the different robot shows at robot station.



Mijuro guard robot (Tsmuk) ; Garbage collecting robot (Fuji Heavy Industries); Wakamura household robot (Mitsubishi)

children. One could experience a ride in an automatic wheelchair, guided by a GPS system while avoiding obstacle and responding to traffic lights. Mitsubishi showed their household robot 'Wakamura' and AIST (National Institute for Advanced Industrial Science and Technology) presented two huge real looking dinosaur robots.

One robot which mostly resembles the 'ANTY' robot of the Vrije Universiteit Brussel is 'Paro', a therapeutical robot created by AIST. This robot is actually commercially available and is intended to ease the minds of patients chained to a hospital bed.

Next to the permanent robot station, during the prototype robot week another 65 prototype robots were exhibited of which the most famous one is the humanoid robot HRP-2 developed by AIST and Kawada Industries. This robot type is used by several

Paro therapeutical robot (AIST)



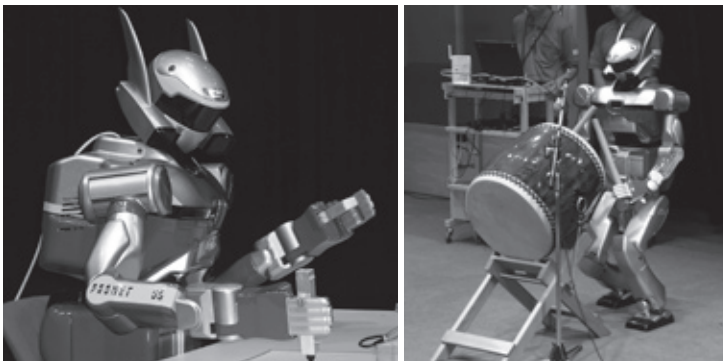
Papero child care robot (NEC)



Dinosaur robot (AIST)

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research teams in Japan and some teams showed the possibilities: a typically Japanese drumming performance, focussing on non trivial impact motion, a vision guided autonomous object picking motion and human-robot conversation in which the robot makes a vision guided drawing of its human interlocutor. It is on this humanoid platform that Dr Björn Verrelst will conduct his research in Japan (see frame).



HRP-2 robot (Kawada industries/AIST) drawing its human interlocutor and playing the drum.

NEDO (New Energy and Industrial Technology Development Organization) a governmental organization provided a total budget of \$ 30 billion dollar for the participating research groups and companies in order to realise the robot exhibition in time. This exhibition was created with special designed scenery in which all the robots were displayed: going from robots climbing trees to cut branches to snake-like swimming robots for underwater inspection tasks. Everywhere separate space was provided for children on the first rows, clearly indicating Japan's focus on children and the enhancement of early interest for technological innovation.



Humanoid robot WABIAN (Waseda University)



Robot suite HAL (University of Tsukuba/ Cyberdyne Inc.)

Besides the HRP-2 and Wabian (Waseda university) humanoid robots, a lot of attention was given to the robot suite HAL (Hybrid Assistive Limb), which is a wearable exoskeleton fortifying a human's power for the assistance during heavy duty tasks such as carrying heavy loads. This device will be commercially available soon at a predicted price of about \$14.000 to \$19.000. A comparable project is started at the Vrije Universiteit Brussel with the development of the step-rehabilitation robot ALTACRO (see frame 'Robots at the Vrije Universiteit Brussel').

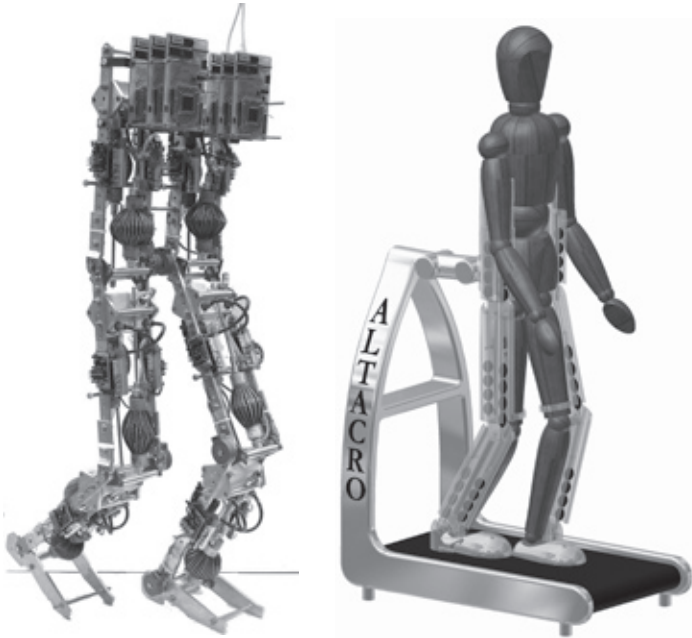
This exhibition was an extremely interesting happening, especially since a lot of different models were exhibited all together. It clearly shows the wide variety of future applications in which research investment will definitely create a lot of economical potential. Since the number of robots on the exposition was extremely high it is not possible to discuss them all in this article, but for more information on the robot journey, the robots of the Vrije Universiteit Brussel and robots in the world in general is referred to the website: <http://lucy.vub.ac.be>.

### Robots at the Vrije Universiteit Brussel

Björn Verrelst en Bram Vanderborght are both researchers at the Robotics and Multibody Mechanics Research group of the Vrije Universiteit Brussel. Their best know experimental robot is Lucy, which is a two legged walking robot that does not use electrical motors but pneumatic artificial muscles for its actuation.

In fact the key research topic of the group is the use of compliant actuation for robotic applications. Compliant actuation for a walking robot (Lucy project) is used to mimic human walking and as such trying to decrease energy consumption. In a robotic manipulator device (Soft Arm project) the compliance is used for safety and ergonomical reasons. A very important drawback of the use of standard electrical drive units is the very stiff interface which makes them less interesting for applications with direct human interaction. A specific field with such kind of interaction can be found in automated rehabilitation training. In this context research is started with the ALTACRO project, which aims at creating a step rehabilitation robot to guide paraplegic patients during their intensive and severe rehabilitation training process. This project has been shortlisted as one of the finalists of the Altran Foundation for Innovation Award 2005.

Recently, the group has developed the 'MACCEPA' actuation principle which is a compliant actuation system with adaptable stiffness, created with a combination of electrical drives and mechanical springs. This system has been patented and is currently being evaluated in a new small-scale bipedal robot 'Veronica'.



Lucy bipedal robot with compliant actuation

ALTACRO project

the child can communicate with parents and friends and through which some specific medical information can be displayed in a child friendly and mind easing manner. Specific attention will be given to the 'soft-touch' of ANTY in order to enhance its acceptance of the children. The research itself will focus on emotion recognition and expression for which the separate research disciplines as digital image processing, speech technology and artificial intelligence will be gathered. One of the major aims of the project for the Vrije Universiteit Brussel is to consolidate a long lasting multidisciplinary research team working around the topic of personal robots and the challenging implementation of robots acting in a human environment.



### ANTY a Child Friendly Cuddle Robot



ANTY is an initiative of Ivan Hermans, president of the Anty foundation vzw, which aims to promote technology amongst children. ANTY will become a cuddle robot which will visit children in a hospital who are chained to their beds for a long period. ANTY will bring the healing function of animals to the children in hospitals, where real animals are not allowed. The robot will have all essential moveable parts in the head of which the large moving nose will be the eye catcher for the children. It will also incorporate a touch-screen in its belly by which

### Tightening Research Connection with Japan

In the field of personal robots Japan is definitely the leading country, as such the aim of the Robotics and Multibody Mechanics Research group is to search for close research collaboration with Japan. A first initiative in this direction is taken by Dr. Björn Verrelst who will work as researcher for one year (from October 2005) in a distinguished robotics research lab in Japan.

He received a post-doctoral JSPS (Japan Society for Promotion of Science) research grant from the Japanese government to conduct research on the famous HRP-2 humanoid robot platform. He is positioned at the Joint Japanese-French Robotics Laboratory (JRL) at the Intelligent Systems Research Institute (ISRI) of the National Institute of Advanced Industrial Science and Technology (AIST), with Dr Kazuhito Yokoi as Japanese host.

His research topic in Japan concerns 'Gait Planning for Humanoid Robots: Negotiating Obstacles' for which strategies will be developed to enhance navigating mobility of humanoid robots in an unstructured human environment.



HRP2 AIST & ROBOTICS INDUSTRIES, INC.