Abstract

After a short introduction in “modern” robotics (industrial robots, mobile robots and humanoid robots) the state of the art of robotics in Austria is evaluated in companies as well as research and University institutes. These results yield to an overview on current robot research and applications in Austria. Companies producing peripherally devices are also included. Finally niches in robotics as future application fields for Austrian activities are identified.

1 Introduction

Robotics is currently a very fast growing field not only in science and industrial application. In the last time more and more mass media are interested in this field because a broader public is in favour to get familiar with these new “intelligent machines”. It is a first step for the realisation of the old dream of humans to have a robot available looking and acting like a human.

According to last estimates the worldwide market for future “advanced” robot systems is forecast to be in excess of € 55 Billion per annum by 2025. Therefore the main task of this contribution is to give Austrian companies as well as research and University institutes a first overview on current activities and future development trends in the field of “modern” robotics.

2 Robots

Industrial robots have been widely applied in many fields to increase productivity and flexibility and to help workers from physically heavy and dangerous tasks.

*Definition according to ISO 8373*: A manipulating industrial robot is an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes which may be either fixed in place or mobile for use in industrial automation applications.

From similar aspects the need on robots in service sectors - like robots in hospitals, in households, in amusement parks - is rapidly increasing.

*Definition*: A service robot is a robot which operates semi- or fully autonomously to perform services useful to well-being of the humans and equipment, excluding manufacturing operations.
Cheap and accurate sensors with a high reliability are the basis for „intelligent“ robots. These intelligent robots can be used for conventional as well as complex applications. Furthermore new applications not only in industry are possible. There are three “starting” points for the development of intelligent robots: Conventional, stationary industrial robots; Mobile, unintelligent platforms (robots) and Walking mechanisms.

![Diagram of robotic applications](image)

**Fig. 1. From Industrial to Service Robots (Kopacek 2005)**

Stationary industrial robots are nowadays equipped with external sensors for “intelligent” operations e.g assembly and disassembly, fuelling cars… and are “intelligent” robots.

Partially intelligent mobile platforms “Autonomous Guided Vehicles – AGV’s” are available since some years and are introduced in industry. Equipped with additional external sensors (Intelligent Autonomous Guided Vehicles – Intelligent AGV’s) are currently slowly introduced in industry and cover a broad application field.

Walking machines or mechanisms are well known since some decades. Usually they have 4 to 6 legs (multiped) and only in some cases 2 legs (biped). Walking on two legs is from the view point of control engineering a very complex (nonlinear) stability problem. Biped walking machines equipped with external sensors are the basis for “humanoid” robots. Some prototypes of such robots are available today (Kopacek, 2005).

In addition these intelligent robots – especially mobile platforms and humanoid robots - are able to work together on a common task in a cooperative way. The goal is so called “Multi Agent Systems – MAS”. A MAS consists of a distinct number of robots (agents), equipped with different devices e.g. arms, lifts, tools, gripping devices … and a host computer. A MAS has to carry out a whole task e.g. assemble a car. The host computer divides the whole task in a number of subtasks (e.g. assembling of wheels, windows, brakes …) as long as all this subtasks can be carried out by at least one agent. The agents will fulfil their subtasks in cooperative way until the whole task is solved.

One of the newest application areas of service robots is the field of entertainment, leisure and hobby because people have more and more free time. In addition modern information
technologies lead to loneliness of the humans (tele-working, tele-banking, tele-shopping, and others). Therefore service robots will become a real “partner” of humans in the nearest future. One dream of the scientists is the “personal” robot. In 5, 10 or 15 years everybody should have at least one of such a robot because the term personal robot is derived from personal computer and the price should be equal (Kopacek, 2008).

3 Robots in Austria

The stock of operational robots in Austria at the end of 2006 reached 4382 units. From these are 2981 for handling and machine tending, 630 for welding and soldering, 225 for processing operations, 128 for assembly and disassembly and the rest of 418 for various applications in use (IFR, 2007).

Fig. 2. Operational stock of industrial robots at year-end in Austria by applications 2005-2006 (IFR 2007)

Fig. 3. Estimated yearly supply of industrial robots at year-end in Austria by main industries 2005-2006 (IFR 2007)
The rubber and plastics industry became the largest application area in 2006, with a share of 29% of the total supply. The number of units purchased increased by 26%. Sales to the metal products industry surged from 19 units to 138 units. The supply to the automotive industry plummeted by 75%. Supplies to general industry – all industries except the automotive – increased by 46% (Fig. 3).

From 18 Institutes of Universities and Universities of Applied Sciences are working 13 in the field of mobile robots, 12 in industrial robots, 11 in software and 4 are developing humanoid robots. 7 Research Centres work mostly in industrial robots, mobile robots and software. 57 Industrial robot or robot components producers - most of them system integrators - deals with Industrial Robots, some specialised in mobile robots.

![Fig.4. Companies and Institutions working in the specified fields of robotics in percent (Kopacek, Gattringer, 2008)](image1)

![Fig.5. Sectioning of industrial robots in percent (Kopacek, Gattringer, 2008)](image2)
In Fig. 5 it can be seen that industry is more active in handling, robots, controllers, programming and applications. The research centres have their maximum in sensors, vision and simulation. For universities, simulation is the main field.

![Fig. 6. Sectioning of mobile robots in percent (Kopacek, Gattringer, 2008)](image)

The activities of the industry in the field of mobile robotics are low. These are mainly Automated Guided Vehicles – AGV’s for transportation purposes. Mobile robots are one of

![Fig. 7. Sectioning of software in percent](image)
the bases of the service robotics. However, nowadays the industry does not focus on this future area.

4 Summary

In 2006 from the 950,974 worldwide installed industrial robots 315,624 or 33.2% were installed in Europe. The 4,382 robots in Austria are 0.46% of the worldwide or 1.38% of the installed robots in Europe.

In the forecast for 2010 there should be 1,173,300 robots worldwide in use. The estimated 380,000 robots in Europe are 32.4%. Under the assumption – according to the trend - 5,000 robots in Austria in 2010 we will have only 0.42% of the robots worldwide and 1.31% of the robots in Europe.

Result: The robot population in Europe in the next three years is, according to this statistic, a little bit slower growing than in the rest of the world. That’s also true for Austria.

Unfortunately there are currently no relevant statistical data available for mobile, intelligent robots.

Austria is quite good represented in the field of robotics. Companies work in all fields of industrial robots – but mostly as system integrators. There are only few of robot producers in Austria. Only 3 of these companies deal with mobile robots and none with humanoids. In contrast to this, Universities and research centres work in nearly all of the listed topics (industrial robots, mobile robots, software and humanoids). The research for industrial robots is mainly done in making robots more lightweight and faster to speed up manufacturing lines.

A lot of work is also done in an enhancement of human machine interface. Future topics like humanoid robots and mobile robots like unmanned vehicles are currently almost handled at universities.

We have in Austria a lot of basic technologies available for future developments. These technologies are ready to be applied to the robotic research and applications in Austria. Examples are the industry oriented topics “Robotic Systems Engineering”, “Intelligent and distributed environment”, “Robot Assistants in Industrial environments”, “Autonomous transport” and “Components and miniaturised robots”. Currently there are only first steps to deal with these new topics. An example are the international very successful Austrian robotsoccer teams in Robocup as well as in FIRA.

According to EUROP (2006) and Kopacek, Gattringer (2008) the topic of “Robotic systems” is of interest for most of the companies and research institutions in Austria.

In this field primarily “Sensing and control” and “Real time control” and secondly “Robotic Systems Engineering”, “Intelligent and distributed environment”, “Flexible manufacturing concepts based on robot-robot cooperation” and “Clusters of robots with coordinated Movement”

“Components and miniaturised robots” could be a future research field for the industry as well as for research and University institutes. “Advanced behaviours” is more or less a theoretical oriented field for University institutes. The industry oriented topics “Robot Assistants in Industrial environments” and “Autonomous transport” are currently underrepresented and should be improved in the future.
Some topics of SRA are currently realised or in realisation e.g. “Sensing and Control” and “Real time control” in Austria mostly in some EC projects e.g. “Homerobots” and “Movement”. Research on “Cost Oriented” solutions is also in progress.

Niches for Austria in Robotics could be new topics - for example:

- “Cost Oriented” tool kits for robotized assembly and disassembly cells – according to the new research headline COA (Cost Oriented Automation).
- Mobile intelligent robots for new applications e.g. humanitarian demining
- Cooperative, intelligent, mobile robot swarms in production
- “End of Life Management – EoL” of robots and robotised cells.
- Safety of mobile robots.

In Austria we are currently at the begin of research activities and industry involvement in “modern” robotics. First results and approaches are available mostly in niches. This trend has to be tremendous improved in the future.

5 References


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