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Development Trends in Robotics

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Abstract: Current developing trends are humanoid robots and robots supporting people in everyday life. Other intensive research areas are cooperative robots, bio inspired robots, ubiquitous robots, cloud robots, modular robots,…….. Micro-, Nano- and Femtorobots are in development and Atorobots are knocking on the door.
This paper is an "upgrade" from Kopacek (2015) because the field of robotics is dramatically changing. Therefore an overview as well as an outlook on future developments will be given with special emphasis to the demands and relations to TECIS.

Keywords: Robots, Control, Roboethics, Social aspects.

1 INTRODUCTION

"Advanced" mobile robots are currently in development and exist mostly as prototypes or in the brain of some scientists or developers. But they will come soon or later. It`s only a question of time.
Therefore, according to the mission of TECIS the social and ethical aspects of these developments have to taken in account as early as possible – that means "NOW".
New questions will arise. For example:
Where is the borderline between robots and intelligent machines like self driving cars?
What will be the role of classic and "advanced" robots in new manufacturing philosophies like "Cyber Physical Systems" which is applied now under the headline "Production 4.0"?

In the following an incomplete selection of possible development trends will be presented and shortly discussed from a personal viewpoint.

2. "NEW" ROBOTS

As mentioned before selected "new" robots will be shortly described and discussed.

2.1 Bioinspired robots: In the past the behaviour of technical systems has often been considered to be very different from that of organic systems. However, there is now increasing interest in looking to bioinspired approaches or using solutions in nature to find responses to technological problems (Kopacek, 2015).

2.2 Micro-,Nano-,Femtorobots

are mobile robots with characteristic dimensions less than 1 micrometer or robots capable of handling micrometer (10^{-6} m) size components.
Nanorobot dimensions are or below 1 micrometer (10^{-6} m), manipulate components on the 1 nm (10^{-9} m) to 1000 nm (10^{-6} m) size range.
Femtorobots for manipulating objects in the 1 fm (10^{-15} m) size are currently more or less a dream and in reality not necessary – because we have nearly no components in this small size.
Nano and femto (sub-atomic particle size) robots may revolutionise medicine and enable a wide range of conditions, such as heart disease and cancer, including currently untreatable serious and life-threatening illnesses to be cured.

2.3 Walking machines

or mechanisms are well known since some decades. Usually they have more than 6 (snake), 4 (multiped) to 6 (hexapod), 2 (biped) or one leg (hopping). Walking on two legs is from the view point of control engineering a complex stability problem. Biped walking machines equipped with external sensors are the basis for "humanoid" robots. Some prototypes of such robots are available today.

2.4 Toy robots

Another of the mostly growing application areas of mobile y (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 (Linert, Kopacek; 2016).

Furthermore such *toy (companion) robots* have a role as toys and companions for children and (young) people. They have a particular role in providing support for autistic children and young adults and have been shown to be able have a role in mediating interaction, including with other children. Robots can also be fun to play and particularly simpler robots can be built from a kit, allowing children and (young) people to learn about technology design and construction, as well as learning to work cooperatively, for instance on the construction of the robot.

2.5 Ubiquitous robots

The term ubiquitous robotics is derived from ubiquitous computing. Basic concepts of ubiquitous robots include networking of every robot, seamless and intuitive operation of user interfaces, robot accessibility at any time and any

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place and the provision of context based services i.e. services which are determined by the particular context.

2.6 Household robots

Household robots are special service robots for support people in their home. They are two categories: Indoor and outdoor robots. The most known and commercially available are for indoor vacuum cleaners and for outdoor lawn cutters and cleaning robots for swimming pools. There are a lot of single purpose research robots usually not commercially available, slow and they need a lot of space.

2.7 Cloud robots

use a cloud computing infrastructure for fast processing of data, particularly data intensive tasks such as image processing and voice recognition. This has the advantages of reducing the memory and processing requirements of the on-board processor or other computing device, since the robot uses the processing power of the cloud computing infrastructure.

For conventional robots, every task, such as moving a foot, grasping an object or recognizing a face, requires a significant amount of processing and pre-programmed information. Consequently, sophisticated systems such as humanoid robots need powerful computers and large batteries on-board to power them. Using the cloud has the advantages of both reducing the need for a powerful computer and large battery on-board and improving the robot's capabilities in areas such as speech recognition, language translation, path planning, and 3D mapping.

One tool for realization is the Robot Operating System (ROS), an open-source flexible framework for writing robot software is a common system for exchanging information through a peer-to-peer network between robots. With a wide compatibility with other applications and the goal of code reuse it's already one of the most used platforms. ROS is compatible with RoboEarth, which provides a platform where robots can share their data like in the internet for humans and make the knowledge easy to use from other robots as well. Same as ROS and RoboEarth in Europe, in the United States RoboBrain got invented with similar skills, just one step above them by providing a knowledge representation layer on top of data storing, sharing and communication.

Communication between human works threw speech and it would be the easiest way to interact with robots in the same way. As speech recognition is a very complex task processed in the cloud, the speech itself can be separated into 4 classes. The simplest class are isolated words, the next are connected words followed by continuous speech and as the most complex the spontaneous speech class, where the robot is always listening. The process starts with digital sampling of speech and processing it via spectral analysis to digital data. After a few filters and algorithm the information is processed to feed the robot with all important information.

Same as speech recognition, grasping need lots of computation power of the cloud. As mentioned above, the grasp planning is done with simulation software and known grasps are saved online for further use of different robots. It refers to image processing or fingertip sensors and is limited due mechanical circumstances.

2.8 Flying robots – Unmanned aerial vehicles (UAV`s)

The field of UAVs has been plagued with different terms to describe the same thing. Even the term UAV or unmanned aerial vehicle is controversial, and it has been replaced in many places with places with UAS or Unmanned Aircraft System. The different terms often came from the different requirements and concepts between military and civilian systems or have regulatory/legal importance.

An unmanned aerial vehicle, refers to a pilotless aircraft, a flying machine without on board human pilot and probably in the future passengers. As such "unmanned" implies total absence of a human who directs and actively pilots the aircraft. Control functions for unmanned aircraft may be either on board or off-board (remote control).

Types of flying Robots

Air Baloon Robots (AirPenguin ,Air Ray,……
- Robots with Rotary Wings
- Wing Flapping Robots

Airplane Robots (Helicopters)
- Sphere drone
- Camcopter S-100
- Tricopter
- Quadcopter
- Pentacopter
- Hexacopter
- Octocopter

Fig. 1. CAMCOPTER (Schiebel Corporation,2016).

As an example the CAMCOPTER® S-100 (Fig 1) is described. This "Unmanned Air System (UAS)" is a proven capability for military and civilian applications. The Vertical Takeoff and Landing (VTOL) UAS needs no prepared area or supporting launch or recovery equipment. It operates, under adverse weather conditions, with a range out to 200 km, both on land and at sea.

The S-100 navigates automatically via pre-programmed GPS waypoints or can be operated directly with a pilot control unit. Missions are planned and controlled via a simple point-and-click graphical user interface. High-definition payload imagery is transmitted to the control station in real time.