LV 64.126

Proseminar Roboter und Aktivmedien

Lecturer

Houxiang Zhang

TAMS, Department of Informatics
University of Hamburg, Germany

@hzhang

Lecture information

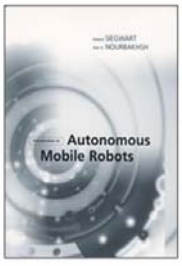
- **Class Schedule: Seminar LV64.126**
  - **Monday, 2:15-4:00pm;**
  - **Location: F 334**
- **Lecturer: Houxiang Zhang**
  - **Office: F307**
  - **Phone: 2565**
  - **Office hours: Friday 11:00 or contact by email**
- **http://tams-www.informatik.uni-hamburg.de/lectures/index.php**

Content of this course

- Introduction to our lecture
- Review of robotic technology
  - What is robot? Review of research achievements
- Different robotic system introduction
  - Mobile robots;
  - Climbing robots;
  - Rescue robots;
  - Medical robots;
  - …
- Other related research topics
  - Navigation; path planning algorithms
  - Application

Acknowledgments

- "***Introduction to Autonomous Mobile Robots***" by Roland Siegwart and IIIah R. Nourbakhsh, and pertinent slides with this book are available on: http://www.mobilerobots.org



- Also thanks for online information from
  - Dr. Alaa Khamis
  - http://gucdiggers.com/robodig/MobileRobotics/

Content of today' lecture

- Introduction to our lecture
  - Motivation, requirements, schedule, and other information;
- What is a robot?
  - Robot's definition; law of robots
- Review of robotic technology
  - History of robots; review of research achievements
- Robots' future

Technical Aspects of Multimodal System
Dept. Informatics, Faculty of Mathematics, Informatics and Natural Sciences
University of Hamburg

Content of today' lecture

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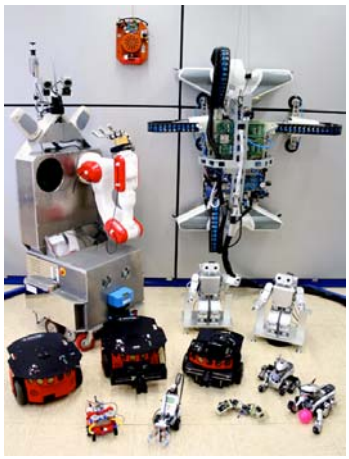
Introduction to our lecture

- Motivation
- Requirements
- Our schedule
- Other useful information



Motivation

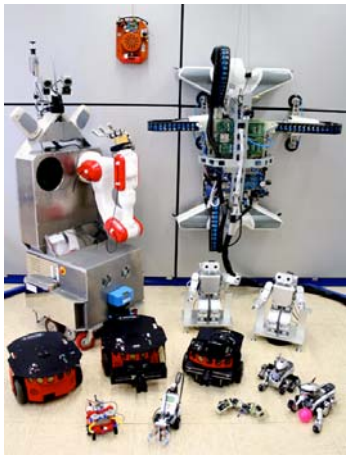
- We will look at different methods from the field of computer science that are used in robotics. The main focus is on the practical use of these methods which will be demonstrated with the help of relevant, up-to-date applications. Presentation subjects can be chosen from among the following areas:
  - Architectures: possibilities of behavior control
  - Mobile robotic technology: motivation- technology-various systems
  - Sensor perception and actuation
  - Man-machine-communication: multimodality, example systems
  - Service robots
  - User detection: gates and gestures
  - Manipulator and Multi-finger Hand

Motivation (cont')

- The main purpose of this seminar is to get to know some selected and very interesting topics within the areas of computer science and robotics.
- This seminar enables the participants to have an insight into some special applications and methods, which can be applied in the robotics.
- There are also some other purposes of this seminar, such as enabling the participants to work independently in a scientifical area, helping you to present the work in oral lecture and in writing documents.

Introduction to our lecture

- Motivation
- Requirements
- Our schedule
- Other useful information



What we require of you

- At the beginning, the lecturer will give some introduction of robotic technology. Then the overall problems are declared by the lecturer at the first lecture.
- It is supported by the discussion at each lecture, where the presenter can be asked. One topic can be handled by up to two participants.
- Each participant makes a presentation which should last more than 30 minutes. The presentation slides and the documents can be prepared with LaTex (Style-File is available) or PowerPoint (Open Office is alternative).

What we require of you (cont')

Other emphasis:

- You should attend the course regularly. Low attendance or absence will affect your grade.
- Three time reasonable absence is the limitation.
- German or English is available. English is encouraged
- Other possibility is still open.
  - Small Schein (only Presentation)
  - Big Schein (Presentation + Report)

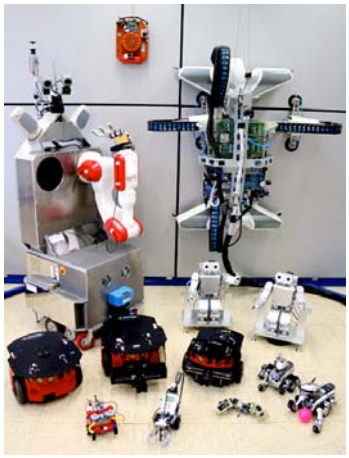
What we require of you (cont')

In order to get your grade:

- ***Send your presentation in PDF to me two days before your oral.***
- ***Give your presentation on time.***
- ***Submit your report in three weeks after your oral presentation.***
- ***Attend other students presentation regularly.***

Introduction to our lecture

- Motivation
- Requirements
- Our schedule
- Other useful information



Our schedule of the seminar part

- Introduction to the seminar
- Review on robotic technology and challenging issues of robotics
- Open topics for you
  - Mobile robots
  - Climbing robots
  - Rescue robots;
  - Medical robots;
  - Navigation and path planning
  - Famous robotic prototypes introduction
  - Introduction to some pre-selected papers on mobile technology

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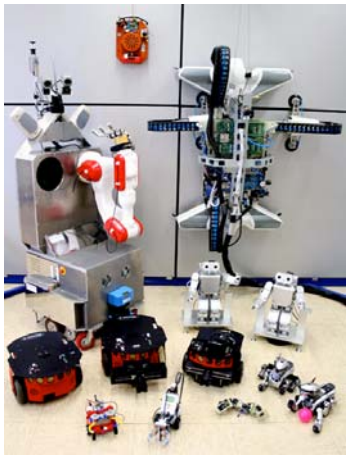

How to find information for your topics

- Our library: numerous journals and proceedings
- Internet
- Our Tams information /informatik/…/tams1.2/tams/proceedings/
- Other literature pre-selected by us

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  - Robot's definition; law of robots
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  - History of robots; review of research achievements
- Robots' future

What is a robot?

- A robot is a mechanical or virtual, artificial agent. It is usually an electromechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own. The word robot can refer to both physical robots and virtual software agents, but the latter are usually referred to as bots to differentiate.[1]

[1] *Telecom glossary "bot". Alliance for Telecommunications Solutions (2001-02-28). Retrieved on 2007-09-05.*

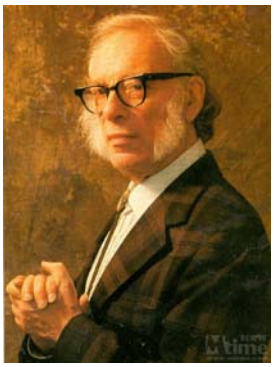
Where does “Robot” come from?

- In 1921 the Czech author Karel Čapek produced his best known work, the play Rossum's Universal Robots.
- "robot" was derived from the Czech word robota, meaning (forced) "work"

1890-1938

Laws of robots from Isaac Asimov 1942

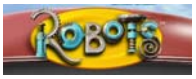
- Law 1:
  - A robot may not injure a human being, or through inaction allow a human being to come to harm.
- Law 2:
  - A robot must obey the orders given it by human beings, except where such orders would conflict with the first law.
- Law 3:
  - A robot must protect its own existence as long as such protection does not conflict with the first or second law.
- Zeroth Law:
  - A robot may not injure humanity, or, through inaction, allow humanity to come to harm.



1920-1992

Robot means what?

Webster Dictionary
An automatic apparatus or device that performs functions ordinarily ascribed to humans or operates with what appears to be almost human intelligence.
Robot Institute of America
A reprogrammable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.



Japanese Industrial Robot Association (JIRA)
A device with degrees of freedom that can be controlled.
International Federation of Robotics (IFR)
An automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes.

Other definitions

- Any device which replaces human labor (Sosoka, Japan, 1985)
- A programmable multifunction manipulator designed to move material, parts, or specialized devices through variable programmed motions for performance of a variety of tasks (Robotics Institute of America, Schlussel, 1985).
- A robot is a machine which can be programmed to do a variety of tasks, in the same way that a computer is an electronic circuit which can be programmed to do a variety of tasks (McKerrow, 1986).
- Robotics is the intelligent connection of perception to action (Mike Brady, Oxford, 1985).

Difference between a machine and a robot

- Two Volkswagen Touareg

Original Volkswagen Touareg

Stanley, Stanford Racing Team
The winner of the 2005 DARPA Grand Challenge

My definition of “robot”

- A robot is an artificial, intelligent, autonomous system with a physical electro-mechanical platform.
- It is a combined device with enough perception, manipulation capability or mobility to implement typical tasks.
- Its purpose is to release human beings of laborious tasks, and of working in a critical environment, or to provide services to improve the our living standard.

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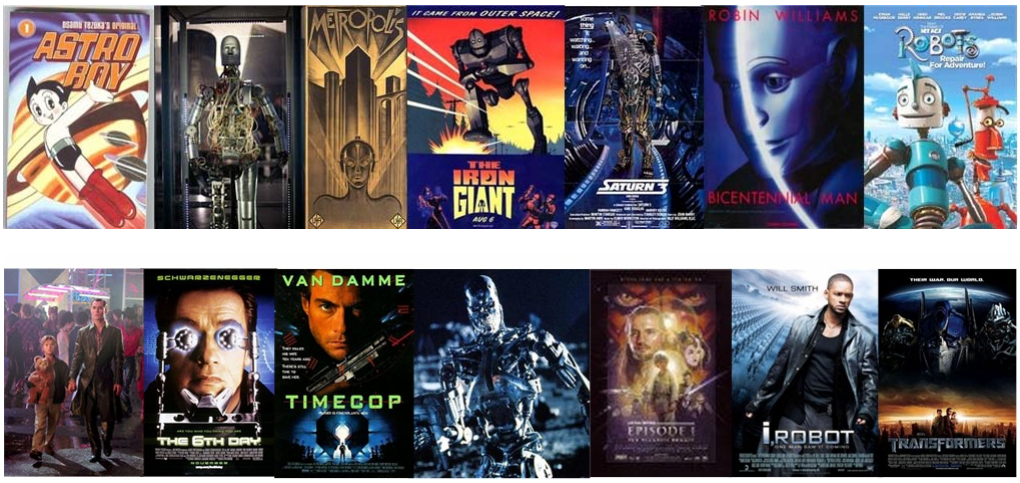
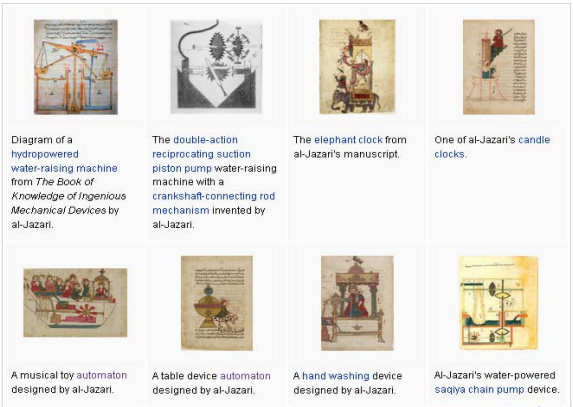
Scientific fictions and movies on robots



History of robots

- Mechanical dolls and other devices
  - Al Jazari (1206AD)



http://en.wikipedia.org/wiki/Al-Jazari

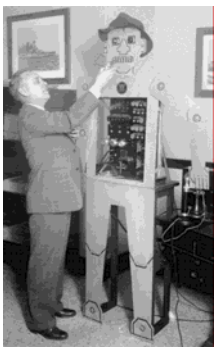
History of robots

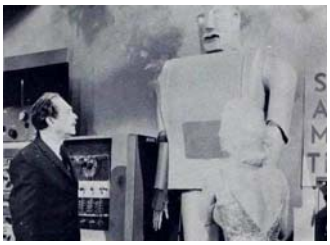
- Mechanical dolls and other devices
  - Automaton in the Swiss Museum CIMA
  - Tea-serving Japanese automaton, "karakuri", with mechanism (right), 19th century

http://en.wikipedia.org/wiki/Automaton

Early research achievements

- In 1926, by Westinghouse Electric Corporation, “Televox” the first robot put to useful work.
- In the 1930s, a humanoid robot “Elektro” for exhibition purposes, including for 1939 and 1940 World's Fairs.



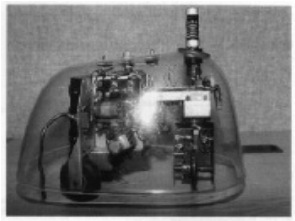


http://en.wikipedia.org/wiki/robot

Early research achievements

- In 1928, by Makoto Nishimura, “Gakutensoku” Japan's first robot.

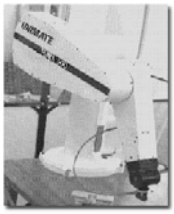
- In 1949, by William Grey Walter, “Elmer and Elsie” , the first electronic autonomous robots. These robots could sense light and contact with external objects, and use these stimulus to navigate.

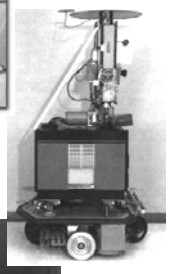


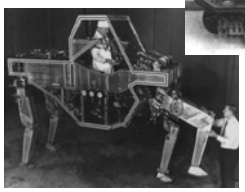
http://en.wikipedia.org/wiki/robot

Early research achievements

- In 1961, by George C. Devol “Unimate”, first industrial robot.
- In 1967, by SRI, Palo Alto, CA. “Shakey”, a small unstable box on wheels to solve problems and navigate in its environment.
- 1960s , by Ralph Moser at General Electric Corp, “General Electric Walking Truck”, a large (3,000 pounds) four legged robot that could walk up to four miles per hour. The walking truck was the first legged vehicle with a computer-brain, developed.







http://en.wikipedia.org/wiki/robot

From 1970s to now…

- Robots have been changing our life from all aspects…

Review of robotic technology

- What is robotics?
- Why should you know something on robots?

  - Robotics is the science and technology of robots, their design, manufacture, and application. Robotics requires a working knowledge of electronics, mechanics and software, and is usually accompanied by a large working knowledge of many subjects.

    http://en.wikipedia.org/wiki/Robotics

  - Robotics is the intelligent connection of perception to action.

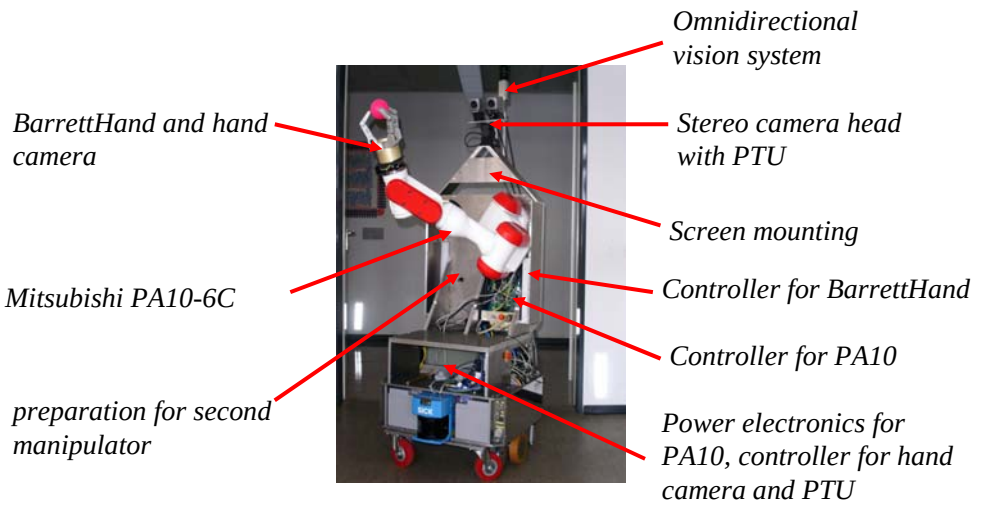
    M.Brady, Artificaial intelligence and Robotics Artifical Inteeligence, 26, pp.79-121,1985

Robotics discipline

- Robotics involves:
  - Methodology: how to implement or design the robots from the system view point
  - System integration: system design
  - Mechanical system and design: realize a physical prototype
  - Kinematics and dynamics
  - Control system design and electrical realization
  - Software integration
  - Control algorithms
  - On-site testing, evaluation, and improvement

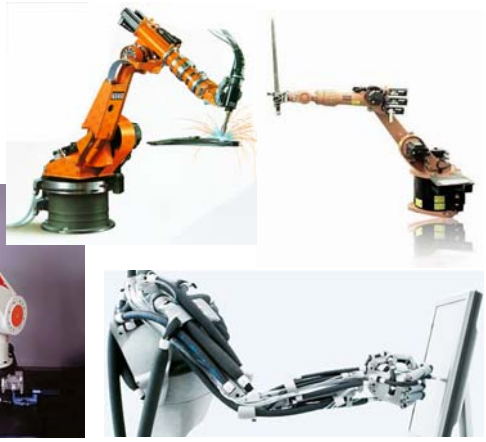
Dr. Houxiang Zhang

An example



Robot Taxonomy

- There are only two kinds of robots primarily according to their mobility:
  - Manipulator robots (Industrial arms)
  - Mobile robots



Mobile robot classification

- According to the environment in which they travel:
  - Land or home robots; aerial robots and underwater robots

- Kinematics
  - Sliding frame robot, legged robot (humanoid robot and multi-leg robot); wheeled robot and chain-tracks

Mobile robot classification

- According to the autonomous levels:
  - Autonomous or semi-autonomous modes
- According to applications
  - Service robots; edutainment robots; pure research prototypes; space robots; and civil or military robots





Review of robotic technology

- What is robotics?
- Why should you know something on robots?
  - Robotics will connect the research, technology with industry and normal life.
  - Robotics will change our life in the following 30 years, it is not only a future technology.
  - Robotics will be more and more popular and absolutely necessary for human society.
  - For you, robotics means a big chance for good future.

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Markets & Challenges

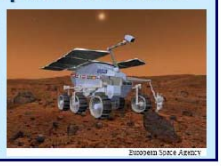
Information Society Technologies

1. Robotics for Industry

2. Service Robotics

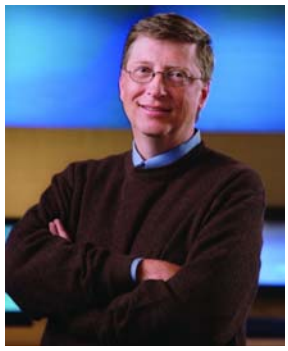
Skywash

3. Security & Space Robotics



Why should you know something on robots?

- Microsoft Chairman Bill Gates lays out the robotic future in the cover story of January's Scientific American Magazine.
  - In the story, Gates argues that the robot industry is akin to the PC industry 30 years ago.
  - Robots will be everywhere in our life.



1955-present

Robots in our life

- Climbing robots
- Multi-legged walking robots
- Robots for Education and entertainment
- Modular robots
- Snake-like robots
- Rescue robots
- Medical system & Surgery robots
- Underwater robots
- Humanoid robots
- Service robots for special tasks
- Industrial robots-robotic arms
- Open topics …

http://www.euron.org/resources/robotgallery.htm

Transportation and service

Personal assistant

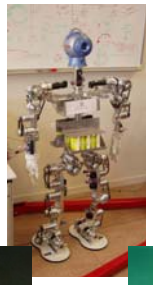





Nursebot



Personal assistant – Humanoid Robots

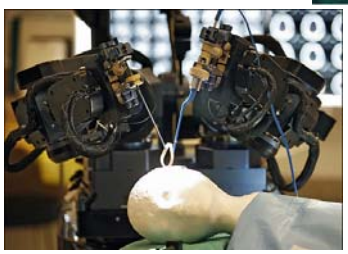




TAMS Humanoid Robots

Medical system & Surgery robots



Cleaning and maintenance




iRobot Scooba 5900 iRobot Scooba 5800

http://www.kaercher.de

Research prototypes

Education and entertainment robots

Edutainment robots – Modular robot

- Main idea: Building robots composed of **modules**
- The design is focused on the module, not on a particular robot
- The different combinations of modules are called **configurations**

- Some advantages:
  - Versatility
  - Fast prototyping
  - Testing new ideas



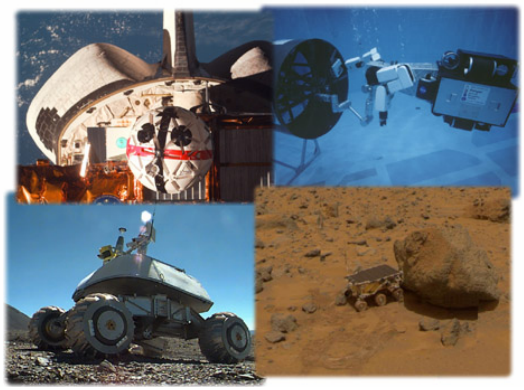

Other example 1 Other example 2

Space exploration robots

The NASA Space Telerobotics Program was shut down in 1997, and the research and technology development tasks supported by the program were transferred to other efforts.

http://ranier.oact.hq.nasa.gov/telerobotics_page/telerobotics.shtm

NASA Space Telerobotics Program



Demining robots

(a) Armtrac 25. (Armtrac Ltd., United Kingdom)

(b) Bozena 4 (WAY Industry J.S. Co, Slovak Republic)

(c) Mini-flail. (US Department of Defense)

(d) Diana 44T (Hontstav S.R.O., Slovak Republic)

(e) Minecat 140. (Norwegian Demining Consortium)

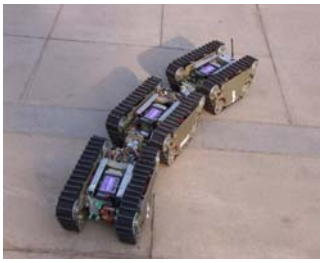
(f) The MV-4. (DOK-ING d.o.o., Croatia)

Agricultural robots

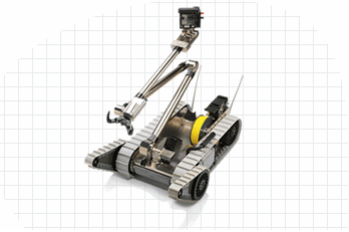
Ag-robots Farm Robots
Illinois University

National Robotics Engineering Consortium
http://www.rec.ri.cmu.edu/projects/demeter/demeter.shtml

Urban search and rescue & military





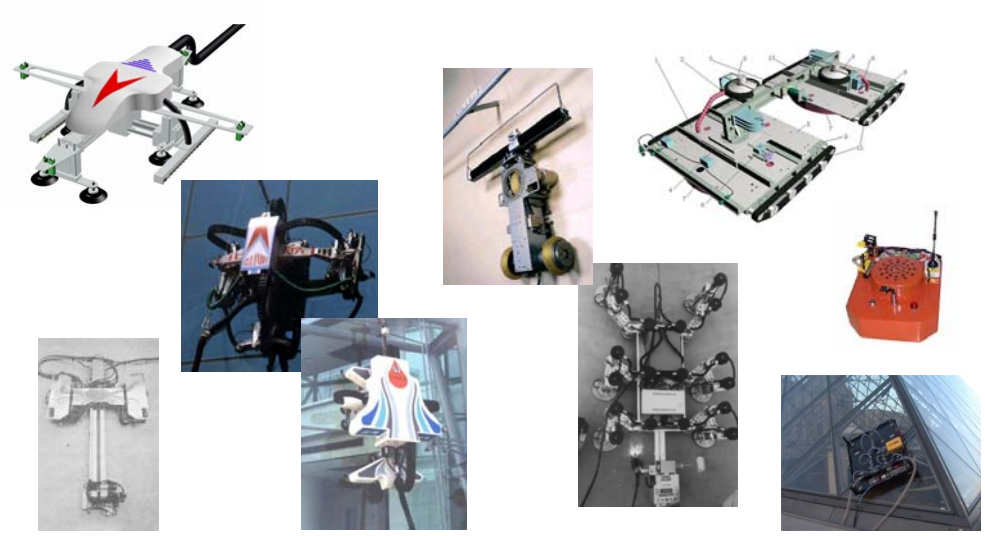



Fire fighting robots





Construction and building maintenance



Inspection robots

- According to the environment in which they travel:
  - Open natural environment

  - Man-made environment

Underwater robots

Other examples

Ph.D. ZHANG, Houxiang hzhang@informatik.uni-hamburg.de
Institute TAMS **Technical Aspects of Multimodal Systems** http://tams-www.informatik.uni-hamburg.de/hzhang

Unmanned aerial vehicle (UAV)

Sub-mini helicopters

MAV/D-25

SUAV/MD-100 SUAV/MD-120 SUAV/MD-180 SUAV/MD200

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Many interesting robotic prototypes

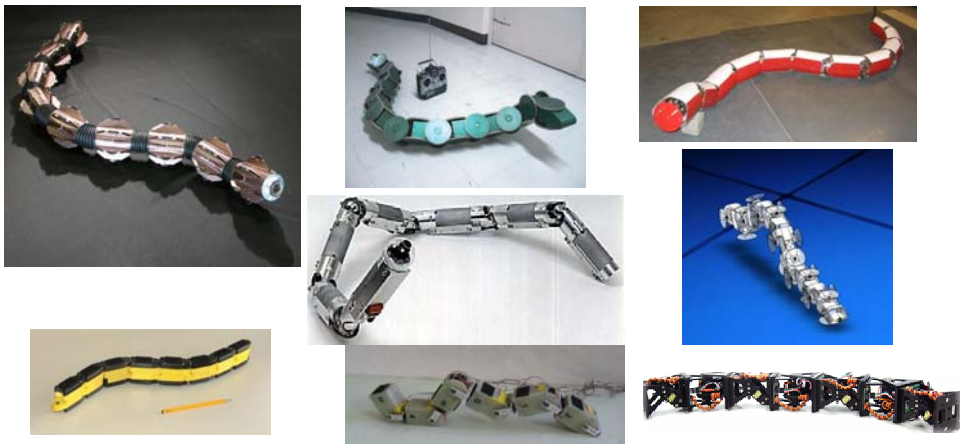
- Legged robots
- Wheeled robots
- Chain-tracked robots
- Sliding frame robots and snake-like robots

http://www.euron.org/resources/robotgallery.html

Wheeled robots

Chain-tracked robots

Snake-like robots



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Thanks for your attention!

Any questions?