ROBOT: DEFINITIONS

- *Origin of the word*: "robota" (Czech) = "work" used in 1921 by Karel Čapek, Czech writer, in his play "R.U.R. (Rossum's Universal Robots)" to name machines created to replace humans.
- *Definition of Webster's dictionary*: **Robot is an automatic device that performs functions ordinarily assign to human beings.** Notice that even washing and drying machines may then be treated as robots...
- *More precise definition of R. I. A.* (Robot Institute of America, 1979): **An (industrial) robot is a** ***programmable, multi-functional*** **manipulator designed to move material, parts, tools, or specific devices, through variable programmed motions for the performance of a variety of tasks.** By that definition, *EVERY* automated industrial machine is a (primitive) robot...

SCIENCE FICTION & ROBOTICS

- *Origin of the word*: **first created and used in 1942 by Isaac Asimov [1920–1992], American scientist and writer.**

- **Asimov's Laws of Robotics:**

  Law 0: **A robot may not injure humanity or, through inaction, allow humanity to come to harm.**

  Law 1: **A robot may not injure a human being or, through inaction, allow a human being to come to harm, unless this would violate a higher order law.**

  Law 2: **A robot must obey orders given it by human beings, except where such orders would conflict with a higher order law.**

  Law 3: **A robot must protect its own existence as long as such protection does not conflict with a higher order law.**

PRESENT STATE-OF-ART

- First generation (50s–70s): robots with no computing or sensory capabilities.
- Second generation (70s–80s): robots with limited computational power and feedback capabilities.
- Third generation (80s–90s): *intelligent* robots with diverse sensing and decision-making capabilities.
- *Short history of the robot industry*:
  - First industrial robot *Unimate* – in the late 50s and early 60s.
  - Very fast growth in the early to mid 80s: automotive, aerospace, military applications, etc.
  - Shakeout from mid 80s to mid 90s due to difficulties of incorporating robots into industrial technologies.
  - Recovery to mid-80's revenue levels – in 1997: robotics worldwide industry – US$ 8 billion; orders for robots and components topped US$ 1.1 billion in 1997 (increase of over 28% from 1996 and over 120% during 1993–97).

Example: IS ROBOTICS

- U.S. company founded in 1990 by Professor R. Brooks, director of the MIT's AI Laboratory, to develop intelligent robots for use in entertainment, commercial, industrial, and advanced research domains.

- *Motto*: Robots for the real world^{TM}

- Close ties to MIT's Artificial Intelligence Laboratory and
  NASA's Jet Propulsion Laboratory; collaboration with UC Berkeley's Poly-PEDAL Laboratory and others.

- Real World Interface Division (robot sales):
  - All Terrain Robots: *ATRV*, *ATRV-Jr*, *ATRV-Micro*;
  - Indoor Robots: *B21r*, *B14r*, *Magellan*, *Mach*;
  - *Urban* Robot;
  - Robotic software: *Mobility*^{TM} CORBA-based modular robotic control architecture;
  - Robotic accessories: computers, vision, communications, laser, speech, navigation.

Example: IS ROBOTICS

- Interactive Toys division: 21st Century Toys
- Research division:
  - Sponsors: Office of Naval Research, Mitsubishi Heavy Industries, Japanese New Energy and Industrial Technology Development Organisation.
  - *Ariel* Autonomous Legged Underwater Vehicle;
  - *Darts* Devices for Acceleration and Rapid Turning;
  - *Fetch II* Counter Mine Intelligence;
  - *Gecko* Component Technologies for Climbing (advanced micro robotics);
  - *Holon 2PLHM* Two Parallel Linked Holonic Mechanisms (36 degree-of-freedom autonomous robot);
  - *MUMS* Micro Unattended Mobility System;
  - *SAFER* Self-Adaptive Software;
  - *Stride* System Tasking and Recon Information Display Equipment;
  - *Urban* robot to aid military operations in urban terrain.
- Energy and Utility division: collaboration with the US company Baker Hughes, Inc (products for the drilling, completion and production of oil and gas wells).

Example: The Robotics Institute (Carnegie Mellon)

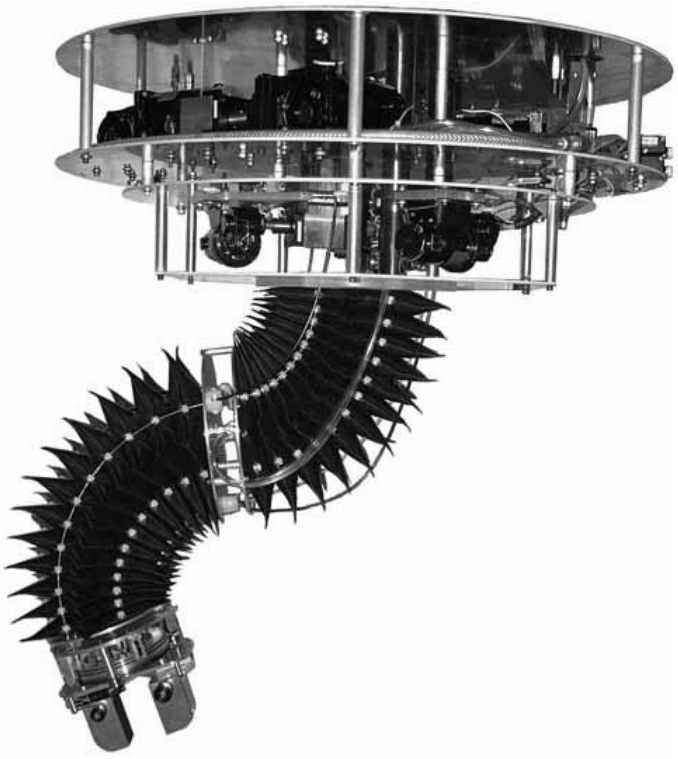
Research projects:

- *Abacus* Automated Tree Measurement;
- *Autonomous Rover Technologies* Pursue breakthroughs and insights into fundamental aspects of robot perception, navigation, position estimation, and integrated exploratory science from a robot (3D radar perception).
- *Bow Leg Hopper* A single-leg dynamically stabilized planar robot for rugged terrains exploration;
- *Dynamic Manipulation* Robot with few DOF can exploit dynamic effects, such as centrifugal and Coriolis forces for better object control;
- *Humanoid Vision* Add visual recognition and navigation to Honda's humanoid robots;
- *Vikia* Developing a robot which bears a personality and behave according to social conventions Display Equipment;

SOME TODAY'S INDUSTRIAL ACTIVITIES

- J.S.Automation (UK): Unimate 2000 and 4000 industrial robots – mould production, machine tool loading.

- Kinetic Sciences (Canada): Tentacle robotic arm.



TODAY'S INDUSTRIAL ACTIVITIES

- Kinetic Sciences (Canada):
  - *Vision Skin* close range image and range sensor
  - *Open Vision* real-time embedded platform for machine vision and robots (3D object recognition and tracking)
  - *Eagle Eye* visual tracking system
  - K.N.T. Engineering (Israel): more than 100 installed robotics and vision systems – in Intel, Iscar, Yam Hemelach Industries, Golan Wineries, etc.

SOME TODAY'S INDUSTRIAL ACTIVITIES

- Robotic Workspace Technologies (USA):
  - URC Universal Robot Controller
  - *RoboScript* robot programming language
- Terra Aerospace Corp. (USA): security robots, robotic equipment for bomb disposal and tactical assault teams
  - *Breacher* tactical robot (remote video investigator)
  - *Merlin* robot for carrying weapons (a camera and a manipulator arm)
  - *SWATbot/Scorpion* robot (remote video investigator)

SOME TODAY'S R&D ROBOTICS ACTIVITIES

- ETL (Japan): robot vision, intelligent machine behaviour, autonomous systems

- NASA (USA): autonomous mobile rovers, space station manipulator systems

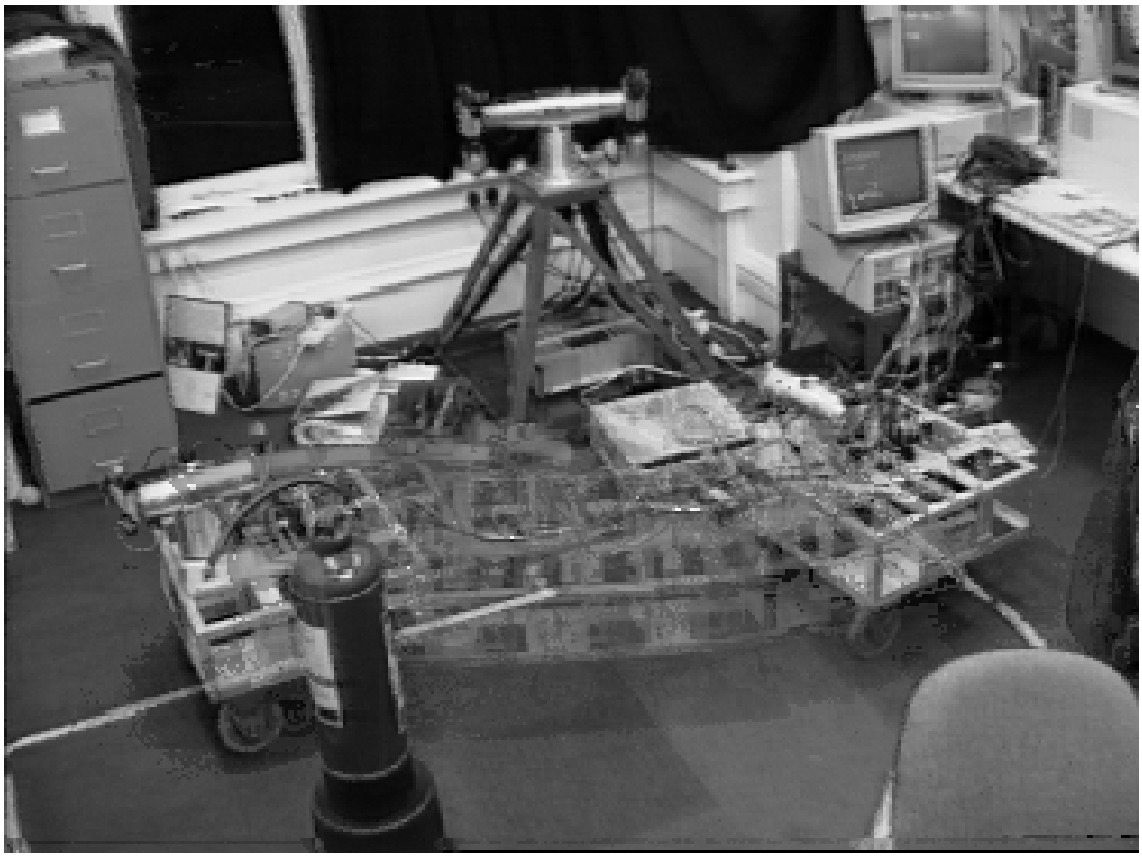
- Oak Ridge National Laboratory (USA): mobile robotics, parallel vision systems, sensor fusion, behaviour-based control

- University of California (Berkeley, USA): *BEAR* Berkeley Aerobot (an autonomous helicopter)

- University of Oxford (UK): GTI mobile platform with self-calibrated robot head to fixate obstacles and make close-loop motions through free-space

SOME TODAY'S R&D ROBOTICS ACTIVITIES

University of Oxford GTI mobile platform:



CONTENTS OF COMPSCI.773.T.SS: Robotics

21 lectures

1. **Robotics: history and applications** (1 lecture)
2. **Features extraction and classification** (3 lectures)
3. **Motion planning** (2 lectures)
4. **Robotic sensing** (1 lecture)
5. **Robotic vision** (2 lectures)
6. **Binary vision** (2 lectures)
7. **2D/3D vision geometry and camera calibration** (3 lectures)
8. **Colour detection/recognition** (2 lectures)
9. **3D scene description/understanding** (1 lecture)
10. **RT image analysis** (1 lecture)
11. **AI basics: reinforcement learning** (3 lectures)

CONTENTS OF COMPSCI.773.T.SS: Real-time control

11 lectures

1. **Discrete Random Processes**
   (2 lectures)

2. **Discrete Linear Systems** (2 lectures)

3. **Adaptive filters** (2 lectures)

4. **Discrete Wiener filtering** (1 lecture)

5. **Stochastic approximation** (1 lecture)

6. **Kalman filtering** (3 lectures)