

Applications of AI

Language and Robots

ITEE Innovation Expo

- **Date:** Thursday, 27 October 2010
- **Time:** 12.00pm – 5.00pm
- **Location:** General Purpose South Building (78).
- www.itee.uq.edu.au/innovation-expo

Robotics

Chapter 25

In which agents are endowed with physical effectors with which to do mischief.

Overview: aims

- To understand some of the issues of Robotics and AI
- To know about some of the applications of Robotics and AI

Overview: topics

- Overview of robotics
- Applications:
 - Social
 - Vehicles
 - Walking
 - Commercial

Robota, robotnik

- The word 'robot' popularized by Czech playwright Karel Capek in R.U.R. (Rossum's Universal Robots) a 1921 play
- robota = obligatory work
- robotnik = serf

What is a robot?

- “To me what makes a robot a robot, ... it's something that senses the world in some way, does some sort of computation, deciding what to do, and then acts on the world outside itself as a result.”
- Rodney Brooks, Newsmaker interview

http://news.cnet.com/Sizing-up-the-coming-robotics-revolution/2008-11394_3-6183596.html

What is a robot?

- Under ISO 8373, a robot is: “An automatically controlled, reprogrammable, multi-purpose manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications.”

– Robotics. An In Depth report from CBC News (July 2007): ‘What is a robot? No simple definition, experts say’

<http://www.cbc.ca/news/background/tech/robotics/definition.html>

Robots

- “Physical agents that perform tasks by manipulating the physical world.”
- Effectors (legs, wheels, grippers, ...)
- Sensors (cameras, ultrasound, ...)

Types of Robots

- Manipulators
 - Factory assembly lines
- Mobile robot
 - Unmanned vehicles, planetary rovers
- Mobile robot with manipulators
 - Humanoids

Sensors

- Passive (Camera)
- Active (Sonar, laser)
- Range finders
- Imaging
- Proprioceptive

Localisation and Mapping

- Simultaneous localisation and mapping (SLAM)
 - A robot constructs a map without knowing where it is in the world
 - More difficult if the environment is dynamic

Path planning

- Kinematics, inverse kinematics
 - Point-to-point motion
 - How to move a robot arm so that it ends up at the desired location without moving through occupied space

Subsumption Architecture

- Different levels of importance assigned to different activities
 - Object avoidance
 - Battery life
 - Exploration

Applications

- Industry and Agriculture
 - part placement, welding, painting, mining ...
- Transportation
 - Helicopters, wheelchairs ...
- Hazardous environments
 - Cleaning up nuclear waste, search and rescue, bombs ...
- Exploration
 - Mars, International Space Station, sunken ships, abandoned mines ...

Applications

- Health care
 - Instrument placement for operations on brains, eyes, and hearts ...
- Personal Services
 - Vacuum cleaners, lawn mowers, golf caddies ...
- Entertainment
 - Sony AIBO, robot soccer ...
- Human Augmentation
 - Legged walking machines, teleoperation, humanoid robots ...

Applications already covered

- Language
- Games

Applications covered in this lecture

- Social
- Vehicles
- Walking
- Commercial

Social

- New range of applications for robots
 - Domestic, entertainment, health care
- Social can mean robot-robot or human-robot interactions
- The research aims to make natural communication between humans and robots possible
- Development of robots that can learn from interaction with humans and the environment
- Social skills includes shared attention & imitation

Social: Abilities

- Expressing / perceiving emotions
- Communicating
- Learning / recognising models of other agents
- Establishing / maintaining social relationships
- Using natural cues
- Exhibiting distinctive personality and character
- Learning / developing social competencies

Social: A Social Robot Definition

- A social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact.
 - Bartneck and Forlizzi (2004)

Social

- Kismet
- Leonardo
- Nexi

Social: Kismet

- Infant-caretaker interaction



<http://www.ai.mit.edu/projects/humanoid-robotics-group/kismet/kismet.html>

Social: Leonardo

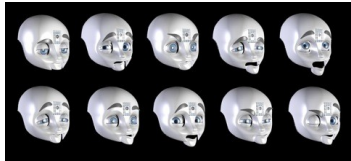
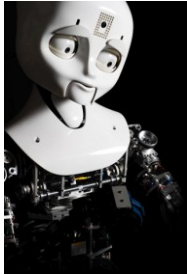
- Face recognition, speech recognition, visual tracking, touch sensor for skin, facial expression, gaze direction, body language, simple object manipulation



<http://robotic.media.mit.edu/projects/robots/leonardo/overview/overview.html>

Social: Nexi

- MDS: Mobile Dexterous Social



<http://robotic.media.mit.edu/projects/robots/mds/overview/overview.html>

Social Robot Labs

- MIT Media Lab, Personal Robots Group
<http://robotic.media.mit.edu/index.html>
- The Social Robotics Labl @ Yale University
<http://qundam.cs.yale.edu/index.html>
- Social Robotics Laboratory @ National University of Singapore
<http://robotics.nus.edu.sg/>
- The Interaction Lab @ University of Southern California
<http://robotics.usc.edu/interaction/>
- Socially Intelligent Machines Lab @ Georgia Institute of Technology
<http://www.cc.gatech.edu/social-machines/>

Vehicles

- Already are some autonomous features in cars e.g. anti-lock braking
- Autonomous vehicles – land, sea, air, space, other worlds

Vehicles

- DARPA Grand Challenge
- DARPA Urban Challenge



- Build an autonomous vehicle capable of driving in traffic, performing complex manoeuvres such as merging, passing, parking and negotiating intersections
- An autonomous ground vehicle is a vehicle that navigates and drives entirely on its own with no human driver and no remote control. Through the use of various sensors and positioning systems, the vehicle determines all the characteristics of its environment required to enable it to carry out the task it has been assigned.

<http://www.darpa.mil/GRANDCHALLENGE/index.asp>

Vehicles: Urban Challenge Carnegie Mellon Tartan Racing

- Lasers, cameras, radars, and 500,000 lines of code allow Boss the Chevy Tahoe to:
 - Follow rules of the road
 - Detect and track other vehicles at long ranges
 - Find a spot and park in a parking lot
 - Obey intersection precedence rules
 - Follow vehicles at a safe distance
 - React to dynamic conditions like blocked roads or broken-down vehicles



<http://www.tartanracing.org/>

Other Vehicles

- Google driverless cars
- AutoNOMOS Labs – Spirit of Berlin, MadeInGermany
<http://www.autonomos.inf.fu-berlin.de/>
- VisLab Intercontinental Autonomous Challenge (Italy to Shanghai, July to October 2010) <http://viac.vislab.it/>

Walking

- Most of the world is not accessible by wheels
- Legs can provide the ability to access these locations
- Understanding how human and other animals walk is scientifically interesting

Walking

- Toddler
- Nonaped
- Self Modelling
- Roller-Walker
- BigDog

Walking: Toddler

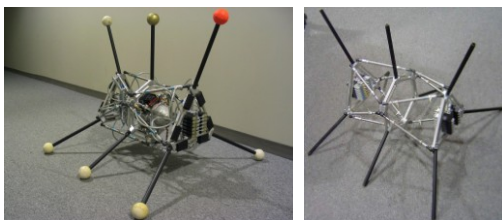
- Learning to walk using neural networks
- Can already walk passively downhill on a treadmill -> learn the same gait without assistance from gravity



<http://groups.csail.mit.edu/ocmotion/russt.html>

Walking: Nonaped

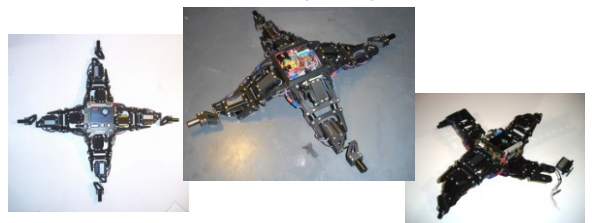
- Pneumatic 12 degree of freedom non-articulated robot
- Gait specified by a 3x24 integer matrix indicating the initial states of the 24 valves and the times at which the valves are inverted (cyclic)
- Genetic algorithm: evaluation, selection, crossover, mutation



<http://ccsl.mae.cornell.edu/research/nonaped/index.html>

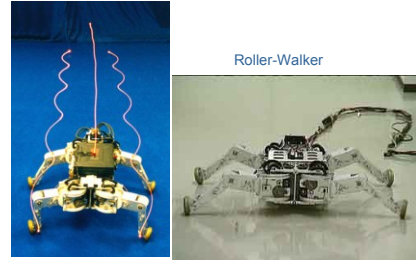
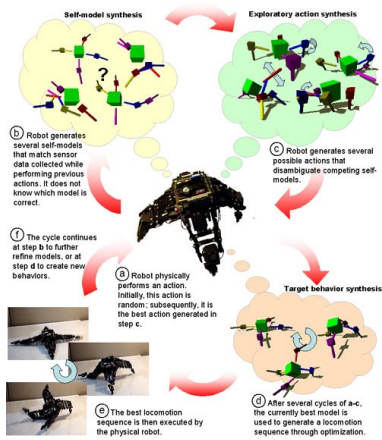
Walking: Robot Introspection, Self Modelling

- 8 motorised joints, 8 joint angle sensors, 2 tilt sensors
- Space of possible models: any planar topological arrangement of 8 limbs, including chains and trees
- Possible actions: desired angles for joints



<http://ccsl.mae.cornell.edu/research/selfmodels/>

Hirose Fukushima Robotics Lab



http://www-robot.mes.titech.ac.jp/robot/walking/rollerwalker/rollerwalker_e.html

Boston Dynamics



www.bostondynamics.com/robot_bigdog.html

Commercial

- iRobot
- Intuitive Automata
- Toys

Commercial: iRobot

- Cleaning
 - Roomba, Scooba, Verro, Looj
- Educational
 - SPARK
- Research



<http://www.irobot.com/>

Commercial: Intuitive Automata

- Autom
- Weight loss coach



<http://www.intuitiveautomata.com/index.html>

Ban on Research Papers on the Evolution of Language

Société de Linguistique de Paris
STATUTS DE 1866

Approuvés par décision
ministérielle du 8 mars 1866

...

ART. 2. - La Société n'admet
aucune communication
concernant, soit l'origine du
langage~ soit la création d'une
langue universelle.

...

Linguistic Society of Paris
STATUTES OF 1866

Approved by ministerial
decision of March 8, 1866

...

ART. 2. - The Society does not
admit any communication
concerning either the origin
of language~ or the creation
of a universal language.

...

www.slp-paris.com/102.html

Multi-disciplinary

- Anthropology
- Archaeology
- Artificial Life
- Biology
- Cognitive Science
- Genetics
- Linguistics
- Modelling
- Palaeontology
- Physiology
- Primatology
- Psychology
- ...

Why is the Evolution of Language Interesting?

- Complex system
- Unique to humans
- Human abilities underlying language
- Understanding human intelligence

Animal Communication

- Bees
- Primates
- Whales
- Birds

Three timescales of language change

- Learning
- Culture
- Evolution

Modern Languages

- No 'primitive' languages
- Pidgins / Creoles
- 'New' languages
 - e.g. Nicaraguan sign language

Computer Modelling

- Specific cognitive or linguistic problem
- Abstraction from reality to focus on the problem
- Predictions from the model

Techniques

- Optimisation
- Genetic Algorithms
- Agent based
- Mathematical

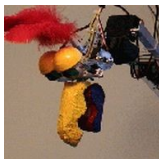
Agent based models

- Language Games
- Iterated Learning
- Population sizes
- Horizontal vs Vertical transmission

Agent-based models of language in robots

- Cognitive Machines Media Lab
- italk
- Artificial Intelligence Laboratory
- ECAgents
- Lingodroids

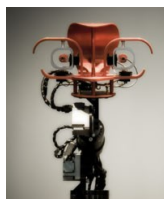
Cognitive Machines MIT Media Lab



Toco



Ripley



Trisk

www.media.mit.edu/cogmac

italk: Integration and Transfer of Action and Language Knowledge in Robots



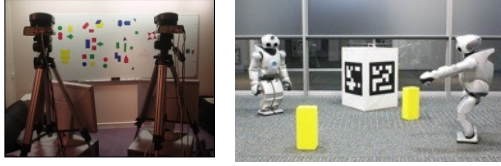
italk



iCub

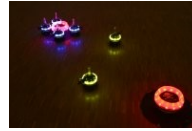
www.italkproject.org

Artificial Intelligence Laboratory



<http://www.youtube.com/watch?v=7u90vEkt1A>
<http://arti.vub.ac.be>

ECAgents Embodied and Communicating Agents



Evolution of Communication in Robot Societies

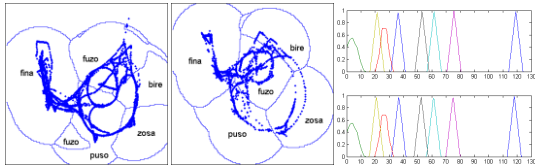


The Perspective Reversal Experiment



The Playground Experiment
<http://ecagents.istc.cnr.it/>

Lingodroids on the iRat



www.lingodroids.org

