EUROP european robotics technology platform

Appendix to:

"Robotic Visions to 2020 and beyond – The Strategic Research Agenda for robotics in Europe, 07/2009"

A tool for roadmapping the ethical, legal, and societal issues in advanced robotics

Version: 1

Date: 7th July 2009

"Robotic Visions to 2020 and beyond – The Strategic Research Agenda for robotics in Europe, 07/2009" can be obtained from:

EUROP Secretariat
c/o EUnited Robotics
Diamant Building, Bd. A. Reyers 80
1030 Brussels, Belgium

Phone: +32 2706-8222
Fax: +32 2706-8223
Email: info@robotics-platform.eu
Internet: www.robotics-platform.eu

Supported by the "Coordination Action for Robotics in Europe", FP6-IST-045058

CARE Coordination Action for Robotics in Europe

1. INTRODUCTION

This document is intended as a tool for roadmapping and analyzing the foremost ELS (Ethical, Legal, and Societal) issues which can be raised by the introduction of Advanced Robotics in our society.

Those issues are identified on the basis of the

ELS NEEDS AND DRIVING FORCES (forecasted over 10 years)

ELS SENSITIVE ISSUES (selected for European societies/culture)

To identifying the **ethical dimension** of technology (needs&issues) involved, it has been referred to :

1) Charter of Fundamental Rights of the European Union (2000/C 364/01) signed and proclaimed by the Presidents of the European Parliament, the Council and the Commission at the European Council meeting in Nice on 7 December 2000, esp.:

- Article 3: Right to the integrity of the person
- Article 13: Freedom of the arts and sciences
- Article 8: Protection of personal data
- Article 10: Freedom of thought, conscience and religion;

2) the United Nations Universal Declaration of Human Rights (10 December 1948, and Amendments), esp. the following items:

- Human Dignity and Human Rights
- Equality, Justice and Equity
- Benefit and Harm
- Respect for Cultural Diversity and Pluralism
- Non-Discrimination and Non-Stigmatization
- Autonomy and Individual Responsibility
- Informed Consent
- Privacy
- Confidentiality
- Solidarity and Cooperation

- Social Responsibility
- Sharing of Benefits
- Responsibility towards the Biosphere.

3) the Council of Europe Convention on Human Rights and Biomedicine.

Here below the main overall driving forces, and LES issues related to the introduction of Advanced Robotics, and to ICT technologies, and which are common to all robotics' fields.

1.1. OVERALL DRIVING FORCES

- Scientific&technological development
- Economic growth
- Market's expansion
- International market competition
- Industrial needs (lack of specialized work force, …)
- Aging of society
- Networked society
- Cultural paradigm/vision of society
- Improving human's quality of life, dignity and health
- Education

1.2. OVERALL ISSUES

- **Dependability**:
  - availability: respect to readiness for usage
  - reliability: respect to continuity of service
  - safety: respect to avoidance of catastrophic consequences on the environment
  - security: prevention of unauthorized access and/or handling

- **Quality/competitiveness**
    - Driving comfort
    - Robustness
    - Autonomy
    - Harmonization/standardisation of robotics systems/products

Trust and acceptability

- Autonomy (also: in some cases a high degree of autonomy may reduce the acceptability's level)
- Human-Robot Interaction
- Position of humans in the control hierarchy
- Non intrusive course of action
- Robots self diagnosis and recovery
- High risk management
- Accountability
- Product's quality (Design, aesthetics qualities, price(benefit,..). Anthropomorphism seems causing issue at least in the European countries
- *PAPA* Code of Conduct:

    Privacy: What information about one's self or one's associations must a person reveal to others, under what conditions and with what safeguards?

    Accuracy: Who is responsible for the authenticity, fidelity and accuracy of information? Similarly, who is to be held accountable for errors in information and how is the injured party to be made whole?

    Property: Who owns information? What are the just and fair prices for its exchange?

    Accessibility: What information does a person or an organization have a right or a privilege to obtain, under what conditions and with what safeguards?

1.3. ROBOTS COMPANION

- Autonomy
- Human-Robot interaction
- Responsibility (Moral and Objective)

  Moral responsibility: requires that the subject exert control over and be aware of the consequences of actions

  Objective responsibility and liability: the causal chain leading to a damage is not clearly recognizable, no one is clearly identifiable as blameworthy

  Objective

- Epistemic limitation of delegating agents

  Theoretical and practical limitations in our ability to explain, predict, and control the behaviour of learning robots in their interactions with humans. Programmers, manufacturers, and users of learning robots may not be in the position to predict exactly and certify what these machines will actually do in their intended operation environments.

- Psychological issues (deviations in human emotions, issues of attachment, disorganization in children, fears, panic, confusion between real and artificial, feeling of subordination towards robots).ü

1.4. GENERAL ISSUES RELATED TO ICT TECHNOLOGIES

- Precautionary principle ("When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically". See: Commission of the European Communities, Brussels, 02.02.2000, com(2000):

  non-instrumentalisation

  non-discrimination

  informed consent and equity

  sense of reciprocity

  data protection.

- Dual use of technology (every technology can be used and misused
- Technological addiction
- Far access to technological resources
- Social and economic discrimination

- Digital divide (per age, gender, social class, nation)
- Social disruption
- Respect of human's physical and mental integrity
- Anthropomorphization of the machines;
- Humanisation of the Human/Machine relationship (cognitive and affective bonds toward machines);
- Replacement of human beings (economic issues; human unemployment; reliability; dependability; and so on)
- ·Effects of technology on the global distribution of wealth and power;
- Environmental impact of technology.

1.5. CHALLENGES

Safety. We should provide for systems for the control of robots autonomy. Operators should be able to limit robots autonomy when the correct robot behaviour is not guaranteed.

Security: H/W and S/W keys to avoid inappropriate or illegal use of the robot

Traceability: like in the case of sensitive systems, we should provide for systems like the aircraft's black box, to be able to register and document robot's behaviours.

Identifiability: like cars and other vehicles, robots too should have identification numbers and serial numbers.

Privacy: H/W and S/W systems to encrypt and password-protect sensitive data needed by the robot to perform its tasks or acquired during its activity.

2. Industrial robotics

- Large structure manufacturing robots.
- Robot systems with integrated process control.
- Flexible manufacturing concepts based on robot - robot cooperation
- Robot Assistants in industrial environments.
- Clusters of robots with coordinated movement (SRA2006)

2.1. DRIVING FORCES

- Increase productivity (speed, endurance)
- Increase quality (precision, cleanness, endurance)
- Make possible highly miniaturized devices
- Substitute for humans in dangerous, heavy, boring, de-humanizing jobs
- Restore the creativity and uniqueness of craftsman's work.

2.2. ISSUES

- Work displacement
- Technical dependability
- Digital divide
- Socio-technological Gap (per ages, social layer, per world areas);
- Fair access to technological resources;
- Effects of technology on the global distribution of wealth and power;
- Environmental impact of technology ("adaptation of the products to life-cycle standards on safety, anti-pollution, on recycling and dismantling rules, according to prescriptions aiming at sustainable development, promulgated by every industrialised Country" *(Euron KA1).*

2.3. CHALLENGES

Welfare policies to facilitate workers' reconversion

Education programs to create new skills

3. Service Robotics - Professional

- Service robots for aerospace maintenance
- Autonomous handling
- Fabricator: “the robot apprentice”
- Mapping inspection robot
- Surgery haptics for tele-diagnostic, training and intervention
- Autonomous transport (SRA 2006).

In anticipation of CARE’s roadmapping of service robots, here some of the fields in which service robots can be applied:

- medical robotics
- health care and rehabilitation
- prosthesis/implants
- Personal robots in clinics or at home for the care of Patient, Elderly, Disabled
- commercial cleaning
- fast food service
- farming
- gasoline station attendant
- underwater applications
- military services
- mining
- construction
- surveillance
- aiding the handicapped and the elderly (See “Robotics in Service” Engelberger)

Schraft and Schmierer (Schraft and Schmierer, 1998) add the following applications:

- fire fighting and rescue robots
- entertainment
- office logistics
- catering and service applications in hotels and restaurants

3.1. DRIVING FORCES

- Capability to manage large scale applications
- Abundant and replaceable interchangeable agents
- Assisting humans in dangerous, impossible, or boring activities
- Better quality of life
- Increased safety and security
- Widening the range/depth of human's activity (in the oceans, lands, ecc)
- Minimally invasive surgery reduces patient recovery time.
- Improved accuracy and precision
- Robotics systems increase precision of microsurgery
- Saving of time in preoperative planning and intraoperative preparation
- Robotics enhance the performance of complex therapies
- Bio-robotics will enhance the life quality after diseases or accidents
- Assistive technology will help many people to conduct a more independent life
- Surgical robots can restore surgeon's dexterity.
- Robotics construction kits can foster the child's learning capabilities
- Robot toys can be intelligent toys: They can be specifically designed to stimulate kids' creativity and the development of their intellectual faculties;
- Robot toys can become kids' companions, and – for lonely children – can play the role of "friend", "brother", or the traditional "imaginary friend";
- Robot toys could be used in the pedagogical assistance of autistic children.
- Sexual robots could decrease the sexual exploitation of women and children.

3.2. ISSUES

- Unpredictability of machine behaviour resulting from machine learning
- Level of transparency of robot actions
- Reduced dexterity, workspace, and sensory input to the surgeon
- Breakdown of surgical robot systems can cause potentially fatal issues
- Issues of size, cost, functionality
- Assignment of liability for misbehaviours or crimes
- Hacker/intrusions vulnerability
- Issues driving from the presence of ubiquitous robots
- Lack of legislation's rules (e.g. Road traffic laws)
- Dependability of primary services on complex systems
- Psychological issues of humans in robotized environments
- Issues deriving from mixed team (humans, robots)

- Unpredictability of robot team behaviour
- Robot surgery: high tech corresponds to high cost
- Issues concerning superhuman, augmentation
- Enhancement versus restoring
- ethical considerations in assisting disabled people by a robot
- Animal experiment
- Increasing isolation of disabled, elderly when robot-assisted

3.3. CHALLENGES

- Update safety and security standards
- Optimization of robot sensors, especially tactile human-machine-interaction and detection of risks and dangers
- Legislation should consider privacy concerns due to intelligent environments
- Need to monitor the mental health of lonely people assisted by artificial environments.
- Create cross committee with bioethics people
- high security and reliability.
- Improving machine learning standards
- Installing a “black box” into learning systems
- Providing machines with explanation & justification facilities
- Distinguishing between classes of non-epistemic errors
- Improving simulation, test, and formal verification methods
- Update international fault tolerance standards to take into account cross-effect complexity
- Reduction of complexity
- Ensure safety and security
- Reduction of end-user price
- Reducing the costs of the robotic systems
- Assessments of risks for patients/doctors

4. Service Robotics - Domestic

- Cleaning robots
- Personal care assistants
- Assistants to elderly, babies, housekeepers
- Sports & Rehabilitation robots
- Fetch & Tidy robots (SRA 2006)

And also

- Intelligent Homes
- Handymen: able to solve many technical issues
- Edutainment (Educational Robotics, robot toys,)
- Entertainment

4.1. DRIVING FORCES

(see Driving forces in *Service robots, Professional*)

4.2. ISSUES

(see Issues in *Service robots, Professional*)

- Lack of human relationships where personal connections are very important (e.g. for elderly care or edutainment applications)
- Responsibility of damage caused by robotic systems.
- Life cycle systems
- Concern about safety and reliability
- Dissemination of misinformation
- Robot Toys could:
  - cause psychological problems:
  - Loss of touch with the real world.
  - Confusion between natural and artificial
  - Confusion between real and imaginary
  - Technology addiction
  - Technology can prevail over creativity
- Sexual robots could raise problems related to intimacy/attachments.

4.3. CHALLENGES

- Educational systems should incorporate Robotics in their programs
- Educational systems should monitor the effects of Robotics in students' learning
- Psychologists should monitor the effects on kids of Robot toys
- Consumer organizations should monitor the safety of the robotics products (reliability, privacy).

5. Security Robotics

Robot agents for security

- Assisting and empowering people to venture into hostile and dangerous areas and acting on behalf of people in the exploration of unknown environments.
- Patrolling
- Surveillance
- Indoor/outdoor security operations
- Surveillance UAV (autonomous airplanes for weather forecast, environmental monitoring, road traffic control, large area survey, patrolling)
- Artificial Sensor Systems
- Augmented Reality
- Exoskeletons

5.1. DRIVING FORCES

- Increases capabilities
- Limited loss of human lives
- Better performances

5.2. ISSUES

- Inability to manage the unstructured complexity of a hostile scenario
- Unpredictability of machine behaviour from machine learning
- Assignment of liability for misbehaviours or crimes
- Humans in mixed teams could face psychological issues.
- Practical and psychological issues having to distinguish humans from robots.
- Overstress and de-humanization of human operators

6. Space Robotics

- Space Exploration (deep space vehicles, landing modules, rovers)
- Space Stations (autonomous laboratories, control & communication facilities)
- Remote Operation (autonomous or supervised dexterous arms and manipulators)
- UAV (autonomous airplanes for weather forecast, environmental monitoring, road traffic control, large area survey, patrolling)

6.1. DRIVING FORCES

- Reduced risk for human crew
- Operations in environment impossible or dangerous for human operators
- More efficient exploitation of natural resources
- Expand earth and space knowledge

6.2. ISSUES

- Excessive density of space objects in the planet's orbits (incidents, pollution, space wrecks)
- Excessive anthropization and exploitation of the solar system
- Technology dual-use: Possible reconversion of civilian robots to devices for military and misuses (terrorism, pollution).