

ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
CCS345 ETHICS AND AI

UNIT IV ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS

Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy.

ROBOETHICS:

Ethics is the **branch of philosophy which studies human conduct**, the concepts of good and evil.

Roboethics --also called machine ethics-- deals with the code of conduct that robotic designer engineers must implement in the Artificial Intelligence of a robot.

Roboethics is a modern interdisciplinary research field lying at the intersection of applied ethics and robotics, which studies and attempts to understand and regulate the ethical implications and consequences of robotics technology, particularly of intelligent/autonomous robots, in our society. The primary objective of roboethics is to motivate the moral design, development, and use of robots for the benefit of humanity.

The term roboethics (for robot ethics) was coined by Gian Marco Verrugio, who defines the field in the following way: “Roboethics is an applied ethics whose objective is to develop scientific/cultural/technical tools that can be shared by different social groups and beliefs. These tools aim to promote and encourage the development of robotics for the advancement of human society and individuals, and to help preventing its misuse against humankind”.

Isaac Asimov developed the Three Laws of Robotics arguing that intelligent robots should be programmed in a way that they obey the following three laws:

- A robot may not injure a human being
- A robot must obey the orders given it by human beings except where such orders would conflict with the First Law
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

ETHICAL CONCERNS

1. **Social cues:** robots should deliver a service that is as human-like as possible.

However, a customer service robot **should not hinder or replace human-to human interactions**. It is important to guarantee this aspect when a company wants to use robots in a service delivery context.

2. **Trust and safety:** The extent to which a robot is deemed safe and trustworthy is important to the user's intention to use the technology. Companies using a service robot must always guarantee the trust and safety.

3. **Autonomy:** Even though, in our case, this variable did not have an influence on the user's intention to use a robot, the idea of being able to restrict a robot's autonomy can be found in ethical charters.

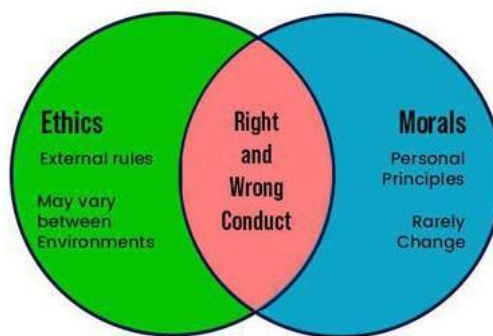
Therefore, we argue that a company using a service robot should always be able to regulate a robot's autonomy, especially in cases when the consequences of the robot's actions cannot be totally controlled.

4. Privacy and data protection: Privacy and data protection play a big role in the intention to use a robot. First, a company using a service robot should always respect its customers' right to privacy. As transparency (i.e., disclosure about what, how and why data is collected) leads to a better user experience, companies (and their robots) have to be transparent about the collection and use of their customers' data. Secondly, companies using customer service robots should ensure that they protect their customer's data by encrypting.

5. Human worker replacement: A company should incorporate its employees in the choices and decisions related to the service robot, such as the choice of the robot, or the decisions related to the definition of its tasks. If a robot takes a worker's job, the firm should retrain its employee for a new occupation.

ETHICS AND MORALITY

ETHICS	MORALITY
1. Ethics is the <u>branch of philosophy</u> concerned with the evaluation of human conduct. 2. Ethics are <u>universal</u> 3. Ethics applies to groups and organizations	1. morality is the right or wrong of an action, <u>a way of life</u> 2. Morality is often <u>culture-specific</u>. 3. morality applies to individuals



Roboethics Methodologies

Roboethics methodologies are developed adopting particular ethics theories. Therefore, before discussing these methodologies, it is helpful to have a quick look at the branches and theories of ethics.

Ethics Branches

Ethics involves the following branches:

_ **Meta-ethics.** The study of concepts, judgements, and moral reasoning (i.e., what is the nature of morality in general, and what justifies moral judgements? What does right mean?).

_ **Normative (prescriptive) ethics.** The elaboration of norms prescribing what is right or wrong, what must be done or what must not (What makes an action morally acceptable? Or what are the requirements for a human to live well? How should we act? What ought to be the case?).

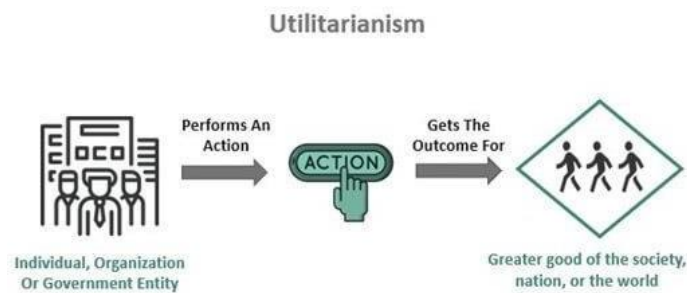
_ **Applied ethics.** The ethics branch which examines how ethics theories can be applied to specific problems/applications of actual life (technological, environmental, biological, professional, public sector, business ethics, etc., and how people take ethical knowledge and put it in practice). Applied ethics is actually contrasted with theoretical ethics.

_ **Descriptive ethics.** The empirical study of people's moral beliefs, and the question: What is the case?



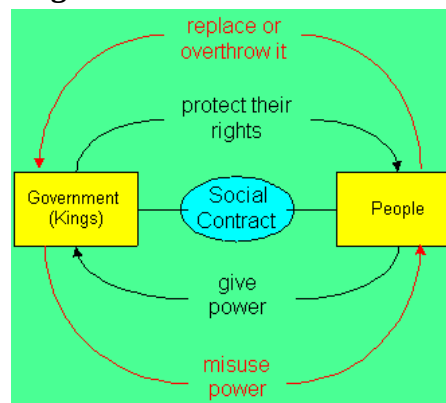
MORAL THEORIES

1. Utilitarianism is a theory of morality that advocates actions that foster happiness and oppose actions that cause unhappiness. Utilitarianism promotes "the greatest amount of good for the greatest number of people."



2. *Contractualism*: is the theory based on the mutual contract between the designer and the contract provider.

An action is morally wrong if it is contrary to the general system of moral rules upon which there could be **informed and unforced agreement**.



3. *Deontologism*;

Deontological ethics is the ethical theory that the morality of an action should be based on whether that action **itself is right or wrong** under a series of rules and principles, rather than based on the consequences of the action.

Ex: 1. Do not kill 2. do not steal 3. do not lie 4. do not cheat etc

Roboethics Methodologies

Roboethics has two basic methodologies: top-down methodology and bottom-up methodology.

Top-down roboethics methodology.

In this methodology, the rules of the desired ethical behaviour the robot are programmed and embodied in the robot system. The ethical rules can be formulated according to the deontological or the utilitarian theory or other ethics theories. The question here is: which theory is the most appropriate in each case? Top-down methodology in ethics was originated from several areas including philosophy, religion, and literature. In control and automation systems design, the top-down approach means to analyse or decompose a tasking simpler sub-tasks that can be hierarchically arranged and performed to achieve a desired output or product. In the ethical sense, following the top-down methodology means to select an antecedent specified ethical theory and obtain its implications for particular situations. In practice, robots should combine both meanings of the top-down concept (control systems meaning and ethical systems meaning).

Deontological roboethics: The first deontological robotic ethical system was proposed by Asimov and involves the following rules, which are known as Asimov's Laws: _

“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 orders it receives from human beings except when such orders conflict with Law 1.

Law 3: A robot must protect its own existence as long as such protection does not conflict with Laws 1 and 2.”

Later, Asimov added a law which he called Law Zero, since it has a higher importance than Laws 1 through 3. This law states:

“Law 0: No robot may harm humanity or through inaction allow humanity to come to harm.”

Asimov's laws are human-centered (anthropocentric) since they consider the role of robot's inhuman service. Actually, these laws assume that robots have sufficient intelligence (perception, cognition) to make moral decisions using the rules in all situations, irrespective of their complexity.

Over the years several multi-rule deontological systems have been proposed, e.g., Their conflict problem is faced by treating them as dictating prima facie duties. In Reference, it is argued that for a robot to be ethically correct the following conditions(desiderata) must be satisfied:

- Robots only take permissible actions.
- All relevant actions that are obligatory for robots are actually performed by them, subject to ties and conflicts among available actions.
- All permissible (or obligatory or forbidden) actions can be proved by the robot (and in some cases, associated systems, e.g., oversight systems) to be permissible (or obligatory or forbidden), and all such proofs can be explained in ordinary English”.

The above ethical system can be implemented in top-down fashion. Consequentialist roboethics: As seen above, the morality of an action is evaluated on the basis of its consequences. The best current moral action is the action that leads to the best future consequences.

A robot can reason and act along the consequentialist/utilitarian ethics theory if it is capable to:

- Describe every situation in the world.
- Produce alternative actions.
- Predict the situation(s) which would be the outcome of taking an action given the present situation.
- Evaluate a situation in terms of its goodness or utility.

“The crucial issues here are how “goodness” is defined, and what optimization criterion is selected for evaluating situations.

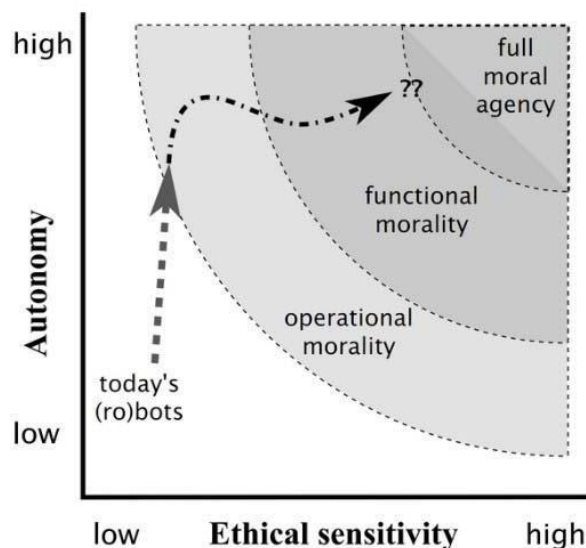
Bottom-up roboethics methodology.

This methodology assumes that the robots possess adequate computational and artificial intelligence capabilities to adapt themselves to different contexts so as to be capable to learn, starting from perception of the world, and then perform the planning of the actions based on sensory data, and finally execute the action. In this methodology, the use of any prior knowledge is only for the purpose of specifying the task to be performed, and not for specifying a control architecture or implementation technique.

Actually, for a robot to be an ethical learning robot both top-down and bottom-up approaches are needed (i.e., the robot should follow a suitable hybrid approach). Typically, the robot builds its morality through developmental learning similar to the way children develop their conscience.

The morality of robots can be classified into one of three levels:

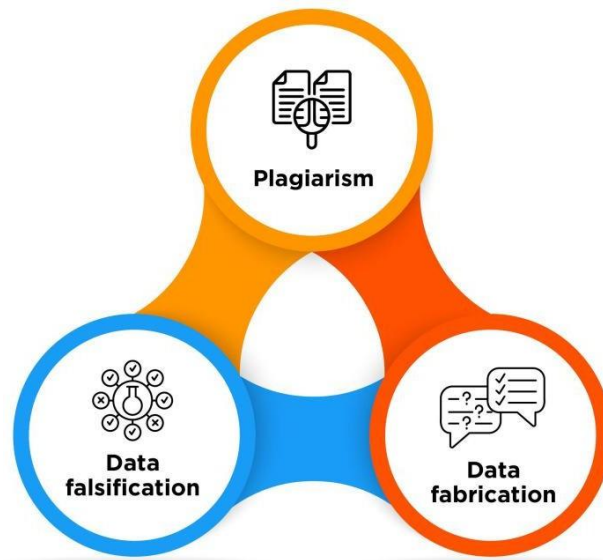
_ Operational morality (moral responsibility lies entirely in the robot designer and user)._
_ Functional morality (the robot has the ability to make moral judgments without top-down instructions from humans, and the robot designers can no longer predict the robot’s actions and their consequences)._
_ Full morality (the robot is so intelligent that it fully autonomously chooses its actions, thereby being fully responsible for them).



ETHICS IN SCIENCE AND TECHNOLOGY

Science ethics: In science, ethical principles, especially **honesty and integrity**, should guide all stages of scientific practice—including **data collection, peer review, publishing, and replication of findings**—to assure that scientific knowledge is unbiased and trustworthy.

BAD PRACTICES:



1. Scientific honesty

Scientists should not commit scientific fraud by, for example, **destroying, or misrepresenting data.**

2. Carefulness

Scientists should avoid **careless errors** in all aspects of scientific work.

3. Intellectual freedom

Scientists should be free to pursue **new ideas and criticize old ones** and conduct research on anything they find interesting.

4. Openness

Whenever possible, scientists should **share data, results**, methods, theories, equipment, and so on; allow people to see their work; and be open to criticism.

5. Attribution of credit

Scientists **should not plagiarise** the work of other scientists. **They should give credit where credit is due but not where it is not due.**

6. Public responsibility

Scientists **should report research** in the public media when the research has an important and direct bearing on human happiness and when the research has been sufficiently validated by scientific peers.

Technology ethics: Ethics in Technology governs principles of right and wrong while using technological advancements.

Examples:

1. The use of **surveillance technologies**.
2. The use of AI to make a **medical diagnosis**.
3. The use of robotic systems in **surgery**.
4. Ethics of **self-driving cars** and their decisions.
5. Ethical issues related to **cloning**.

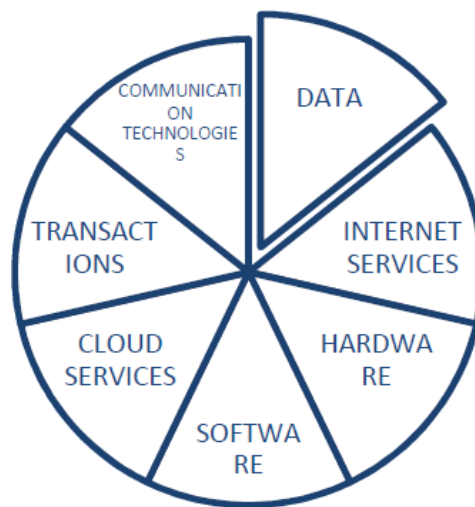
6. Ethics related to implantable medical devices such as **pacemakers**.
7. The ethics of **hacking** for security testing purposes.
8. Use of technology such as **cryptocurrency**.
9. The **environmental impact** of technology.
10. **Internet of things** and the embedding of networked devices into everyday things.
11. The impact of **social media** on society.
12. The use of **AI in education**.
13. **Screen time** and its impact on children.

Ethical Issues in an ICT Society

Information and communication technologies (ICT) is defined as a diverse set of technological tools and resources used **to transmit, store, create, share or exchange information**.

Information Technology have a wide area of applications in **education, business, health, industries, banking sector**.

COMPONENTS OF ICT:



To deal with ICT society it is important to find out the ethical issues.

Some of the major ethical issues faced by Information & communication Technology (ICT) are:

1. Personal Privacy
2. Access Right
3. Harmful Actions
4. Copyright
5. Liability
6. Piracy

1. Personal Privacy

Due to the distribution of the network on a large scale, **data or information transfer** in a big amount takes place which leads to the **hidden chances of disclosing information** and violating the privacy of any individuals or a group.

2. Access Right

Network on the internet cannot be made secure from **unauthorized access**. Generally, the intrusion detection system is used to determine whether the **user is an intruder or an appropriate user**.

3. Harmful Actions

Harmful actions in the computer ethics refers to the **damage to the IT** such as loss of important information, loss of property, loss of ownership. To recover from the harmful actions extra time and efforts are required to **remove the viruses** from the computer systems.

4. Copyright

Copyright law works as a very powerful legal tool in protecting computer software, both before a **security breach and after a security breach**.

5. Liability

Software developer should be aware of the liability issue in making ethical decisions.

Software developer makes **promises about the nature and quality** of the product that is given as **warranty**.

6. Piracy

Piracy is the creation **of illegal copy** of the software. The software industry is prepared to do encounter against software piracy. The courts are dealing with an increasing number of actions concerning the protection of software.

Harmonization of Principles

Harmonization is the act of **making systems or laws the same or similar** in different companies, countries, etc. so that they can work together more easily.

Internationally recognized institutions such as the United Nations, the World Health Organization (WHO), have identified general ethical principles that have been adopted by most nations, cultures, and people of the world.

Furthermore, the international scientific, community has proposed a harmonization of world ethical principles applied to science and technology, especially in those cases when these principles involve sensitive issues such as life, human dignity, and freedom.

Three kinds of integration are analysed:

1. Human–softbot integration, as achieved by AI research on information and communication technologies. A softbot (software robot) is a program that interacts with a software environment by issuing commands and interpreting the environment's feedback.
2. Human–robot non-invasive integration, as achieved by robotic research on autonomous systems inhabiting human environments
3. Physical, invasive integration, as achieved by bionic research

Ethics and Professional Responsibility

In the design, development, and application of a new technology, designers, manufacturers, and end users should be following rules, which are common to all human beings:
human dignity and human rights

- equality, justice
- benefit and harm
- respect for cultural diversity
- non-discrimination
- autonomy and individual responsibility
- informed consent

- privacy and confidentiality
- cooperation
- sharing of benefits
- responsibility towards the biosphere
- cost-benefit analysis

Computer and information ethics have developed a code of ethics called *PAPA*

Privacy: What information about one's self or one's associations must a person reveal to others

Accuracy: Who is responsible for the authenticity

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

Professionals are advised to apply, in performing sensitive technologies, the

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.

All over the world, associations and orders of engineers have adopted codes of ethics guiding towards responsible conduct in research and practice.

security and reliability are the most important ethical codes of conduct.

ROBOETHICS TAXONOMY

Roboethics Taxonomy refers to the classification of types of Robots available and the ethics corresponding to their usage.

1. Humanoids: A humanoid robot is a robot **resembling the human body** in shape.

Artificial intelligence will be able to lead the robot to fulfil the missions required by the end users.

To achieve this goal, over the past decades' scientists have worked on AI techniques in many fields, including:

1. Artificial vision
2. Perception of the environment
3. Natural language processing
4. Human interaction
5. Machine learning
6. Neural networks

1. Humanoid Ethics: one of the fundamental aspects of the Humanoid robots is their capability to **learn the characteristics** of the surrounding environment.

Humanoid intelligence is a **learned intelligence**, fed by the world models uploaded by the designers.

The increasing autonomy of the robots could give rise **to unpredictable** and nonpredictable behaviours.

Hence the designers must **predict** the threats and foresee the dangers.

2. Industrial Robotics

An industrial robot is officially defined by ISO as an automatically controlled, reprogrammable, multipurpose manipulator.

Typical applications of industrial robots include welding, painting, assembly, pick and place etc

Ethical issues in Industries: Social problems stemming from the introduction of robots in factories are the loss of jobs and unemployment.

Ethically, the loss of job by the introduction of Industrial robots should be compensated by giving an alternate job like

1. Maintenance of the Robot
2. A new skill etc

3. Adaptive Robot Servants

Adaptive Robo servants are Service robots that support and back up human operators.

Robots come in several shapes and sizes (wheeled, legged, humanoids), equipped with different kinds of sensing systems (artificial vision systems, ultrasonic, radio) and manipulations (grippers, hands, tools, probes).

Ethical Issues for ROBOT servants:

- Designers must guarantee safety and Security
- Overuse could lead to technology addiction or invasion of privacy

4. Distributed Robotic Systems

Distributed Robotic systems are **Networked Robotic systems that are linked to the web.**

A full-scale robot team would be of tremendous value in a number of applications such as security, surveillance, monitoring, gardening, and pharmaceutical manufacturing.

Ethical Issues in Distributed Robotic systems:

- unpredictability of behaviour due to the availability of a team of several systems.
- Assignment of Liability for Misbehaviour
- Vulnerability to hacking

5. Outdoor Robotics

- Outdoor robots are intelligent machines that explore, develop, secure our world.
- Rescue robotics (robots that support first-response units in disaster missions)
- Agricultural (autonomous tractors, planters and harvesters, applicators for
- fertilizers and pest control)
-

Issues in using Outdoor Robots:

Use of outdoor robots could lead to excessive exploitation of the planet, which can become a threat to biodiversity and life on the planet.

6. Surgical Robotics

Surgical Robots are robots that allow doctors to perform many types of complex surgeries with more precision, flexibility and control than is possible with conventional techniques.

Typical applications are:

- Robotic tele surgical workstations
- Robotic systems for diagnosis (CT Scan – Computerized Tomography Scan)

Issues:

- High cost of robotic systems in the medical field could widen the **digital divide** between developed and developing countries

Roboethics Branches

In the following we will outline the following roboethics branches:

- Medical roboethics.
- Assistive roboethics.
- Sociorobot ethics.
- War roboethics.
- Autonomous car ethics.
- Cyborg ethics.

Medical Roboethics

Medical roboethics (ethics of medical robots or health care robots) uses the principles of medical ethics and roboethics. The fundamental area of medical robotics is the area of robotic surgery, which finds increasing use in modern surgery. Robotic surgery has excessive cost. Therefore, the question that immediately rises is : “Given that there is marginal benefit from using robots, is it ethical to impose financial burden on patients or the medical system?”. The critical issue in medical ethics is that the subject of health care and medicine refers to human health, life, and death. Medical ethics deals with ethical norms for the medical or health care practice, or how it must be done.

The principles of medical ethics are based on the general theories of ethics (justice as fairness, deontological, utilitarian, case-based theory), and the fundamental practical moral principles (keep promises, do not interfere with the lives of others unless they request this form of help, etc.)

According to the well-known Georgetown Mantra (or six-part medical ethics approach), all medical ethical decisions should involve at least the following principles:

- “Autonomy: The patients have the right to accept or refuse a treatment.
- Beneficence: The doctor should act in the best interest of the patient.
- Non-maleficence: The doctor/practitioner should aim “first not to do harm”.
- Justice: The distribution of scarce health resources and the decision of who gets what treatment should be just.
- Truthfulness: The patient should not be lied to and has the right to know the whole truth.
- Dignity: The patient has the right to dignity”.

An authoritative code of ethics is the AMA (American Medical Association) code.

Robotic surgery ethics is a sub-area of applied medical ethics, and involves at minimum the above Georgetown Mantra Principles. Medical treatment of any form should be ethical. However, a legal treatment may not be ethical. The legislation provides the minimum law standard for people’s performance. The ethical standards are specified by the principles of ethics and, in the context of licenced professionals (robotics engineers, information engineers, medical doctors, managers, etc.),are provided by the accepted code of ethics of each profession.

Injury law places on all individuals a duty of reasonable care to others, and determines this duty based on how “a reasonable/rational person” in the same situation would act. If a person (doctor, surgeon, car driver) causes injury to another, because of unreasonable action, then the law imposes liability on the unreasonable person. Figure shows a snapshot of the DaVinci robot and its accessories.

A branch of medicine which needs specialized ethical and law considerations is the branch of telemedicine (especially across geographical and political boundaries). Telecare from different countries should obey the standard ethics rules of medicine, e.g., the rules of confidentiality and equipment reliability, while it may reduce the migration of specialists. Confidentiality is at risk because of the possibility of overhearing. Here, the prevention of carelessness in the copying of communications such as diagnoses is necessary, along with the assurance that non-physician intermediaries (e.g., medical technicians or information experts) who collect data about patients respect confidentiality. Communication should be sufficiently fast so as to assure that the ethical requirements of beneficence and justice are met, and to reduce the unpleasant anxiety of the patients.

On the legal side, the so-called conflict of laws should be properly faced. A first issue is whether a medical care professional, who has a licence to practice only in jurisdiction A but treats a patient in jurisdiction B, violates B’s laws. Conflict of law principles should be applied here. The ethical standards are specified by the principles of ethics and, in the context of licenced professionals (robotics engineers, information engineers, medical doctors, managers, etc.), are provided by the accepted code of ethics of each profession.

Injury law places on all individuals a duty of reasonable care to others, and determines this duty based on how “a reasonable/rational person” in the same situation would act. If a person (doctor, surgeon, car driver) causes injury to another, because of unreasonable action, then the law imposes liability on the unreasonable person. A scenario concerning the case of injuring a patient in robotic surgery is discussed in Reference. Figure shows a snapshot of the DaVinci robot and its accessories.



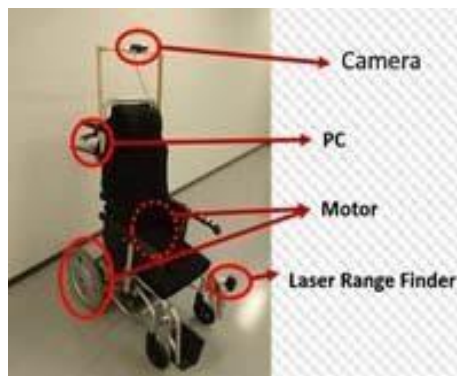
The Da Vinci surgical robot system

Assistive Roboethics

Assistive robots constitute a class of service robots that focuses on the enhancement of the mobility capabilities of impaired people (people with special needs: PwSN) so as to attain their best physical and/or social functional level, and to gain the ability to live independently.

Assistive robots/devices include the following:

- Assistive robots/devices for people with impaired lower limbs (wheelchairs, walkers).
- Assistive robots/devices for people with impaired upper limbs and hands.
- Rehabilitation robots/devices for upper limbs or lower limbs.
- Orthotic devices.
- Prosthetic devices.



(a)



(b)

Figure (a) shows the principal components of the Toyama University's intelligent/self-navigated wheelchair, and Figure (b) shows the McGill University's multi-task mart/intelligent wheelchair (smart wheeler).

The evaluation of assistive robots can be made along three main dimensions, namely: cost, risk, and benefit. Since these evaluation dimensions trade off against each other we cannot achieve full points on all of them at the same time. Thus, their quantitative evaluation and the trade-off among the different dimensions is needed. The evaluation of risk-benefit and cost-benefit should be conducted in light of the impact of assistive technologies on users' whole life in both the short term and the long-term. Important guidelines for these analyses have been provided by the World Health Organization (WHO), which has approved an International Classification of Functioning, Disability, and Health (ICF).

Assistive robotics is part of medical robotics. Therefore, the principles of medical roboethics (Georgetown Mantra, etc.) and the respective codes of ethics are applicable here. Doctors and caregivers should carefully respect the following additional ethical aspects:

1. Select and propose the most appropriate device which is economically affordable by the PwSN.
2. Consider assistive technology that can help the user do things that he/she finds difficult to do.
3. Ensure that the chosen assistive device is not used for activities that a person is capable of doing for him/herself (which will probably make the problem worse).
4. Use assistive solutions that respect the freedom and privacy of the person.

5. Ensure the users' safety, which is of the greatest importance.

A full code of assistive technology was released in 2012 by the USA Rehabilitation Engineering and Assistive Technology Society (RESNA), and another code by the Canadian Commission on Rehabilitation Councillor Certification (CRCC) was put forth in 2002. A four-level ethical decision-making scheme for assistive/rehabilitation robotics and other technologies is the following: _

Level 1: Select the proper device—Users should be provided the proper assistive/rehabilitation devices and services, otherwise the non-maleficence ethical principle is violated. The principles of justice, beneficence, and autonomy should also be followed at this level.

_ **Level 2:** Competence of therapists—Effective co-operation between therapists in order to plan the best therapy program. Here again the principles of justice, autonomy, beneficence, and non-maleficence should be respected.

_ **Level 3:** Effectiveness and efficiency of assistive devices—Use should be made of effective, reliable, and cost-effective devices. The principles of beneficence, non-maleficence, etc. should be respected here. Of highest priority at this level is the justice ethical rule.

_ **Level 4:** Societal resources and legislation—Societal, agency, and user resources should be appropriately exploited in order to achieve the best available technologies. Best practices rehabilitation interventions should be followed for all aspects.

Sociorobot Ethics

Sociorobots (social, sociable, socialized, or socially assistive robots) are assistive robots that are designed to enter the mental and socialization space of humans, e.g., PaPeRo, PARO, Mobiserv, i-Cat and NAO. This can be achieved by designing appropriate high-performance human-robot interfaces: HRI (speech, haptic, visual). The basic features required for a robot to be socially assistive are to:

- _ Comprehend and interact with its environment.
- _ Exhibit social behavior (for assisting PwSN, the elderly, and children needing mental/socialization help).
- _ Direct its focus of attention and communication on the user (so as to help him/her achieve specific goals).

A socially interactive robot possesses the following capabilities:

- _ “Express and/or perceive emotions.
- _ Communicate with high-level dialogue.
- _ Recognize other agents and learn their models.
- _ Establish and/or sustain social connections.
- _ Use natural patterns (gestures, gaze, etc.).
- _ Present distinctive personality and character.
- _ Develop and/or learn social competence.”

Some more sociorobots, other than those shown in Figure, include the following:

- _ AIBO: a robotic dog (dogbot) able to interact with humans and play with a ball (SONY).
- _ KISMET: a human-like robotic head able to express emotions (MIT).
- _ KASPAR: a humanoid robot torso that can function as mediator of human interaction with autistic children.
- _ QRIO: a small entertainment humanoid (SONY).

Sociorobots are marketed for use in a variety of environments (private homes, schools, elderly centers, hospitals). Therefore, they have to function in real environments which includes interacting with family members, caregivers, and medical therapists. Normally, a sociorobot does not apply any physical force on the user, although the user can touch it, often as part of the therapy. However, in most cases no physical user-robot contact is involved, and frequently the robot is not even within the user's reach. In most cases the robot lies within the user's social interaction domain in which a one-to-one interaction occurs via speech, gesture, and body motion. Thus, the use of sociorobots raises a number of ethical issues that fall in the psychological, emotional, and social sphere.

In addition, the following fundamental non-physical (emotional, behavioral) issues should be considered:

- _ "Attachment: The ethical issue here arises when a user is emotionally attached to the robot. For example, in dementia/autistic persons, the robot's absence when it is removed for repair may produce distress and/or loss of therapeutic benefits.

- _ Deception: This effect can be created by the use of robots in assistive settings (robot companions, teachers, or coaches), or when the robot mimics the behavior of pets.

- _ Awareness: This issue concerns both users and caregivers, since they both need to be accurately informed of the risks and hazards associated with the use of robots.

- _ Robot authority: A sociorobot that acts as a therapist is given some authority to exert influence on the patient. Thus, the ethical issue here is who controls the type, the level, and the duration of interaction. If a patient wants to stop an exercise due to fatigue or pain a human therapist would accept this, but a robot might not accept. Such a feature is also to be possessed by the robot.

- Autonomy: A mentally healthy person has the right to make informed decisions about his/her treatment. If he/she has cognition problems, this autonomy right is passed to the person who is legally and ethically responsible for the patient's therapy.
- Privacy: Securing privacy during robot-aided interaction and care is a primary requirement in all cases.
- Justice and responsibility: This is of primary ethical importance to observe the standard issues of the "fair distribution of scarce resources" and "responsibility assignment".
- Human-human relation (HHR): HHR is a very important ethical issue that has to be addressed when using assistive and socialized robots. The robots are used as a means of addition or enhancement of the therapy given by caregivers, not as a replacement of them."

- **Autonomy:** A mentally healthy person has the right to make informed decisions about his/her treatment. If he/she has cognition problems, this autonomy right is passed to the person who is legally and ethically responsible for the patient's therapy.
- **Privacy:** Securing privacy during robot-aided interaction and care is a primary requirement in all cases.
- **Justice and responsibility:** This is of primary ethical importance to observe the standard issues of the "fair distribution of scarce resources" and "responsibility assignment".
- **Human-human relation (HHR):** HHR is a very important ethical issue that has to be addressed when using assistive and socialized robots. The robots are used as a means of addition or enhancement of the therapy given by caregivers, not as a replacement of them."



(a)



(b)



(c)



(d)



(e)

Figure. Examples of sociorobots.

(a) PaPeRo (b) PARO (c) Mobiserv (d) i-cat (e) NAO

War Roboethics

Military robots, especially lethal autonomous robotic weapons, lie at the center of roboethics. Supporters of the use of war robots state that these robots have important advantages which include the saving of the lives of soldiers and the safe clearing of seas and streets from IED (Improvised Explosive Devices). They also claim that autonomous robot weapons can expedite war more ethically and effectively than human soldiers who, under the influence of emotions, anger, fatigue, vengeance, etc., may overreact and overstep the laws of war. The opponents of the use of autonomous killer robots argue that weapon autonomy itself is the problem and the mere control of autonomous weapons would never be satisfactory. Their central belief is that autonomous lethal robots must be entirely prohibited.

War is defined as follows (Merriam Webster Dictionary):

- _ A state or period of fighting between countries or groups.
- _ A state of usually open and declared armed hostile conflict between states or nations.
- _ A period of such armed conflict.

The three dominating traditions (doctrines) in the ethics of war and peace are:

- Realism (war is an inevitable process taking place in the anarchical world system).
- Pacifism or anti-warism (rejects war in favor of peace).
- Just war (just war theory specifies the conditions for judging if it is just to go to war, and conditions for how the war should be conducted).

The international law of war or international humanitarian law attempts to limit the effects of armed conflict for humanitarian purposes. The humanitarian *jus in bello* law has the following principles:

1. Discrimination: It is immoral to kill civilians, i.e., non-combatants. Weapons (non-prohibited) may be used only against those who are engaged in doing harm.

2. Proportionality: Soldiers are entitled to use only force proportional to the goal sought.

3. Benevolent treatment of POWs: Captive enemy soldiers are “no longer engaged in harm”, and so they are to be provided with benevolent (not malevolent) quarantine away from battle zones, and they should be exchanged for one’s own POWs after the end of war.

4. Controlled weapons: Soldiers are allowed to use controlled weapons and methods which are not evil in themselves.

5. No retaliation: This occurs when a state A violates *jus in bello* in war in state B, and state B retaliates with its own violation of *jus in bello*, in order to force A to obey the rules.

In general, a war is considered a just war if it is both justified and carried out in the right way. The ethical and legal rules of conducting wars using robotic weapons, in addition to conventional weapons, includes at minimum all of the rules of just war discussed above, but the use of semiautonomous/autonomous robots adds new rules as follows:

- Firing decision: At present, the firing decision still lies with the human operator. However, the separation margin between human firing and autonomous firing in the battlefield is continuously decreased.
- Discrimination: The ability to distinguish lawful from unlawful targets by robots varies enormously from one system to another, and present-day robots are still far from having visual capabilities that may faithfully discriminate between lawful and unlawful targets, even in close contact encounter.



Figure: Autonomous fighter examples (MQ-1 Predator, M12). and Autonomous fighter examples (MQ-1 Predator, M12).

Autonomous Car Ethics

Autonomous (self-driving, driverless) cars are on the way. Proponents of autonomous cars and other vehicles argue that within two or three decades autonomously driving cars will be so accurate that they will exceed the number of human-driven cars. The specifics of self-driving vary from manufacturer to manufacturer, but at the basic level cars use a set of cameras, lasers, and sensors located around the vehicle for detecting obstacles, and employ GPS (global positioning systems) help them to move along a preset route.



Figure. Basic sensors of Google's driverless car.

Currently there are cars on the road that perform several driving tasks autonomously (without the help of the human driver). Examples are: lane assist systems to keep the car in the lane, cruise control systems that speed up or slow down according to the speed of the car in front, and automatic emergency braking for emergency stops to prevent collisions with pedestrians. SAE (Society of Automotive Engineers) International (www.sae.org/autodrive) developed and released a new standard (J3016) for the "Taxonomy and definitions of terms related to on-road motor vehicle automated driving systems".

This standard provides a harmonized classification system and supporting definitions which:

- "Identify six levels of driving automation from 'no automation' to 'full automation'.
- Base definitions and levels on functional aspects of technology.
- Describe categorical distinction for step-wise progression through the levels.

- Are consistent with current industry practice.
- Eliminate confusion and are useful across numerous disciplines (engineering, legal, media, and public discourse).
- Educate a wide community by clarifying for each level what role (if any) drivers have in performing the dynamic driving task while a driving automation system is engaged.”

The fundamental definitions included in J3016 are:

- “Dynamic driving tasks (i.e., operational aspects of automatic driving, such as steering, braking, accelerating, monitoring the vehicle and the road, and tactical aspects such as responding to events, determining when to change lanes, turn, etc.).
- Driving mode (i.e., a form of driving scenario with appropriate dynamic driving task requirements, such as expressway merging, high-speed cruising, low-speed traffic jam, closed-campus operations, etc.).
- Request to intervene (i.e., notification by the automatic driving system to a human driver that he should promptly begin or resume performance of the dynamic driving task).”

SAE level	NHTSA level	BAST level	Steering, braking & acceleration	Monitoring of driving environment	Fallback performance	System capability
No Automation	0	Driver only	Human	Human	Human	none
Driver Assistance	1	Assisted	Human and system	Human	Human	
Partial Automation	2	Partially automated	System	Human	Human	
Conditional Automation	3	Highly automated	System	System	Human	
High Automation	3/4	Fully automated	System	System	System	
Full Automation		—	System	System	System	All driving modes

Figure: shows the milestones needed to be passed on the way to meeting the final goal of fully automated vehicles, according to SAE, NHTSA (National Highway Traffic Safety Administration), and FHRI (Federal Highway Research Institute).

Cyborg Ethics

Cyborg technology aims to design and study neuromotor prostheses in order to store and reinstate lost function with a replacement that is as similar as possible to the real thing (a lost arm or hand, lost vision, etc.). The word cyborg stands for cybernetic organism, a term coined by Manfred Clynes and Nathan Kline. A cyborg is any living being that has both organic and mechanical/electrical parts that either restore or enhance the organism's functioning. People with the most common technological implants such as prosthetic limbs, pacemakers, and cochlear/bionic ear implants, or people who receive implant organs developed from artificially cultured stem cells can be considered to belong to this category. The first real cyborg was a "lab rat" created at Rockland State Hospital in 1950 (New York, www.scienceabc.com). The principal advantages of mixing organs with mechanical parts are for human health.

For example:

- "People with replaced parts of their body (hips, elbows, knees, wrists, arteries, etc.) can now be classified as cyborgs.
- Brain implants based on neuromorphic model of the brain and the nervous system help reverse the most devastating symptoms of Parkinson disease."

Disadvantages of cyborgs include:

- _ "Cyborgs do not heal body damage normally, but, instead, body parts are replaced.
- Replacing broken limbs and damaged armor plating can be expensive and time-consuming.
- Cyborgs can think of the surrounding world in multiple dimensions, whereas human beings are more restricted in that sense".



Figure 9. An example of cyborg eye.

Three of the world's most famous real-life cyborgs are the following:

- The artist Neil Harbisson, born with achromatopsia (able to see only black and white) is equipped with an antenna implanted into his head. With this eyeorg (electronic eye), he became able to render perceived colors as sounds on the musical scale.

- Jesse Sullivan suffered a life-threatening accident: he was electrocuted so severely that both of his arms needed to be amputated. He was fitted with a bionic limb connected through a nerve-muscle grafting. He then became able to control his limb with his mind, and also able to feel temperature as well as how much pressure his grip applies.
- Claudia Mitchell is the first woman to have a bionic arm after a motorcycle accident in which she lost her left arm completely.



(a)



(b)



(c)

Figure 10. Examples of human cyborgs. (a) Neil Harbison, (b) Jesse Sullivan, (c) Claudia Mitchell.