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Science and Engineering

Spyros G. Tzafestas

Roboethics

A Navigating Overview

 Springer

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*To my loving grandchildren Philippos,
Myrto and Spyros*

Preface

Morals are based on the knowledge of universal ideas, and so they have a universal character.

Plato

Relativity applies to physics, not to ethics.

Albert Einstein

The aim of this book is to provide a navigating introductory overview of the fundamental concepts, principles and problems in the field of *roboethics* (robot ethics). Roboethics is a branch of applied ethics that attempts to illuminate how the ethical principles can be applied to address the delicate and critical ethical questions arising in using robots in our society. Ethics has its origin in ancient philosophy that has put the analytic foundations on determining what is *right* and *wrong*. The Greek philosophers advocated models of life with the *human* as their central value (“*valeur par excellence*”).

Robotics has been developed along these lines, i.e., robotics in the *service of mankind*. Robotics is directly connected to human life; medical robotics, assistive robotics, service-socialized robotics and military robotics all have strong impact on human life and pose major ethical problems for our society. Roboethics is receiving increasing attention within the fields of *techno-ethics* and *machine ethics*, and a rich literature is available that covers the entire spectrum of issues from theory to practice.

The depth and width of the presentation in this book is sufficient for the reader to understand the ethical concerns of designers and users of intelligent and autonomous robots, and the ways conflicts and dilemmas might be resolved. The book is of a tutorial nature, convenient for novices in the field, and includes some conceptual non-technical material of artificial/machine intelligence, the robot world with emphasis on the types and applications of robots, and mental robots that possess, besides cognition, intelligence and autonomy capabilities, consciousness and conscience features.

The book can be used both as a supplement in robotics courses and as a general information source. Those who are planning to study roboethics in-depth will find this book a convenient consolidated start.

I am deeply indebted to the Institute of Communication and Computer Systems (ICCS) of the National Technical University of Athens (NTUA) for supporting the project of this book, and to all colleagues for granting their permission to include in the book the requested pictures.

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Spyros G. Tzafestas

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Chapter 1

Introductory Concepts and Outline of the Book

The best way of life is where justice and equity prevail.

Solon

The best way to teach morality is to make it a habit for the children.

Aristotle

1.1 Introduction

Roboethics is a new field of robotics which is concerned with both the positive and negative implications of robots to society. The term *roboethics* for “*robot ethics*” was coined by *Verrugio* [1]. Roboethics is the ethics that aims at inspiring the moral design, development and use of robots, especially intelligent/autonomous robots. The fundamental issues addressed by roboethics are: the dual-use of robots (robots can be used or misused), the anthropomorphization of robots, the humanization of human-robot symbiosis, the reduction of socio-technological gap, and the effect of robotics on the fair distribution of wealth and power [2]. According to the Encyclopaedia Britannica: “Robot is any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner”. In his effort to find a connection between humans and robots *Gill* [3] concludes that: “Mechanically, human beings may be thought as direct-drive robots where many muscles play a role of direct drive motors. However, contradictory to science fiction, humans are much superior to robots in the structural point of view because the densities of muscles and bones of humans are an order lower than steel or copper, which are the major structural materials for robots and electrical motors”.

The purpose of this chapter is:

- To provide a preliminary discussion of the concepts of roboethics and robot morality levels.
- To give a short literature review of roboethics.
- To explain the scope and provide an outline of the book.

1.2 Roboethics and Levels of Robomorality

Nowadays there is a very rich literature on roboethics covering the whole range of issues from theoretical to practical roboethics for the design and use of modern robots. Roboethics belongs to techno-ethics which deal with the ethics of technology in general, and to machine ethics which extends computer ethics so as to address the ethical questions in designing and using intelligent machines [4, 5]. Specifically *roboethics* aims at developing scientific, technical and social ethical systems and norms related with the creation and employment of robots in society. Today, in advanced research in computer science and robotics, the effort is to design *autonomy* which is interpreted as the ability required for the machines and robots to carry out autonomously intellectual human-like tasks. Of course, autonomy in this context should be properly defined since it might be misleading. In general, “autonomy is the capacity to be one’s own person to live one’s life according to reasons and motives taken as one’s own and not the product of external forces” [6].

Autonomy in machines and robots should be used in a narrower sense than humans (i.e., metaphorically). Specifically, machine/robot autonomy cannot be defined absolutely, but only relatively to the goals and tasks required. Of course we may frequently have the case in which the results of the operations of a machine/robot are not known in advance by human designers and operators. But this does not mean that the machine/robot is a (fully) autonomous and independent agent that decides what to do by its own. Actually, machines and robots can be regarded as partially autonomous agents, in which case we may have several levels of “*autonomy*” [7]. The same is true for the issues of “*ethics*”, where we have several levels of “*morality*” as described in Sect. 5.4, namely [8]:

- Operational morality
- Functional morality
- Full morality

Actually, it would be very difficult (if not impossible) to describe ethics with sufficient precision for programming and fully embedding it to a robot. But, the more autonomy a robot is provided and allowed to have, the more morality (ethical sensitivity) is required by the robot.

In general, ethics within robotics research must have as central concern to warn against the negative implications from designing, implementing and employing robots (especially autonomous robots). This means that, in actual life, roboethics should provide the moral tools that promote and encourage the society and individuals to keep preventing misuse of the technological achievements in robotics against the human kind. Legislation should provide *efficient and just* legal tools for discouraging and preventing such misuse, and assigning liability in case of harm due to robot misuse and human malpractice.

1.3 Literature Review

We start with a brief outline of the seminal Special Issue “*Ethics in Robotics*” of the International Review of Information Ethics (Vol. 6, December 2006). This issue, edited by *R. Capurro*, contains thirteen contributions, offered by eminent researchers in the field of roboethics, that cover a wide set of fundamental issues.

G. Veruggio and F. Operto present the so-called “Robotics Roadmap” [9], which is the result of a cross-cultural interdisciplinary discussion among scientists that aim at monitoring the effects of current robotic technologies to society.

P.M. Asaro deals with the question “what we want from a robot ethic”, and argues that the best approach to roboethics is to take into account the ethics built into robots, the ethics of those designing and using robots, and the ethics of robot use.

A.S. Duff is concerned with justice in the information age following the neo-Pawisian approach for the development of a normative theory for information society. Aspects that are suggested to be considered include political philosophy, social and technological issues, the rights prior to good, social well-being and political stability.

J.P. Sullins investigates the conditions for a robot to be a moral agent, and argues that the questions which must be addressed for the evaluation of robot’s moral status are: (i) Is robot significantly autonomous? (ii) Is the robot behaviour intentional?, and (iii) Is the robot in a position of responsibility?

B.R. Duff explores the fundamental differences of humans and robots in the context of social robotics, and discusses the issue of understanding how to address them.

B. Becker is concerned with the construction of embodied conversational agents (robots and avatars) for human-computer interface development. She argues that this construction aims to provide new insights in the cognition and communication based on the creation of intelligent artifacts, and on the “idea” that such a mechanical human-like dialog will be beneficial for the human-robot interaction. The actual plausibility of this is put as an issue of discussion.

D. Marino and G. Tamburini are concerned with the moral responsibility and liability assignment problems in the light of epistemic limitations on prediction and explanation of robot behaviour that results by learning from experience. They argue that roboticists cannot be freed from all responsibility on the sole ground that they do not have full control over the causal chains implied by the actions of their robots. They rather suggest to use legal principles so as to fill the responsibility “gap” that some authors accept to exist between human and robot responsibility (i.e., that the greater the robot autonomy the less responsible the human).

C.K.M. Grutzen explores the vision of future and daily life in “ambient intelligence” (**AmI**). The assumption is made that intelligent technology should disappear into our environment in order to bring humans an easy and entertaining life. He argues that to investigate whether humans are in danger to become just objects of artificial intelligence, the relation between mental, physical, methodical invisibility and visibility of **AmI** should be examined.

S. Krebs investigates the influence of “mangas” (comics) and “animes” on the social perception and cultural understanding of robots in Japan. This includes the interaction between population culture and Japanese robotics. The *Astro* boy comics is used in order to examine the ethical conflicts between robots and humans that occur in Japanese mangas.

M. Kraehling investigates how Sony’s robodog *Aibo* challenges the interpretation of other life forms by humans and how concepts of friendship are held. He argues that ethical issues about human perceptions of dogs in the era of doglike robots must be investigated, and that *Aibo* itself does not belong to a predefined category. It actually belongs somewhere in an intermediate space, i.e. it does not live in a really mechanistic world not in the animals world.

N. Kitano investigates the motivation for the popularity of socialized robots in Japan. The effects of them on human relations, and the customs and psychology of the Japanese are considered. First, the Japanese social context is described to illustrate the term “*Rinri*” (ethics, social responsibility). Then the meaning of Japanese “*Animism*” is explained to understand why *Rinri* is to be considered as an incitement of Japanese social robots.

M.A. Pérez Alvarez is concerned with the transformation of the educational experiences into the class rooms which are necessary for the development of intellectual abilities of children and teenagers. It is argued that the process of “arming and programming” *LEGO-type Mind Storms* enhances the young people’s live experiences that favour the development of intelligence, and so it provides a useful education process in the class room.

D. Söffler and J. Weber discuss the question whether an autonomous robot, designed to communicate and make decisions in a human-like way is still a machine. The concepts, ideas and values on which such robots are based are discussed. The way they relate to everyday life and how far the social demands drive the development of such machines are examined. The question “whether the human-robot relationship changes” was investigated via an e-mail dialogue on ethical and socio-political aspects, especially on private life.

Some of the concepts and results derived in the above works will be discussed further in the book. We now continue with reviewing a few other important works on roboethics.

In [8], *Wallach and Allen* consider the question “can a machine be a genuine cause of harm? They argue and conclude that the answer is affirmative. They predict that within a number of years “there will be a catastrophic incident brought about by a computer system making a decision independent of human oversight”. They examine deeply the need of machine morality, where we are at present, and conclude that this could be achieved.

In [10], *Capurro* recapitulates a number of his researches regarding the epistemological, ontological, and psychoanalytic implications of the relation between humans and robots, and about the ethical issues of human-machine interaction. He argues that the human-robot relation can be regarded as an envy relation in which humans either envy robots for what they are or they envy other humans for having

robots that they do not have. Regarding the ethics of man-machine interaction the following questions are addressed:

- (i) How do we live in a technological environment?
- (ii) What is the impact of robots on society?
- (iii) How do we (as users) handle robots? What methods and means are used today to model the interface between man and machine?

In [11], *Lin, Abney and Bekey* bring together prominent researchers and professionals from science and humanities to explore questions like: (i) Should robots be programmed to follow a code of ethics, if this is possible? (ii) How might society and ethics change with robots? (iii) Are there risks in developing emotional bonds with robot? (iv) Should robots, whether biological, computational hybrids, or pure machines be given rights or moral consideration? Ethics seems to be slow to follow the technological progress, and therefore the opinions of the contributors to the book are very helpful for the development of a “roboethics”.

In [12], *Fedaghi* proposes a classification scheme of ethical categories to simplify the process by which a robot may determine which action is most ethical in complicated situations. As an application of this scheme Asimov’s robot laws are decomposed and rephrased to support logical reasoning. Such an approach is in-line with the so-called procedural ethics.

In [13], *Powers* proposes a rule-based robot ethics system based on the assumption that the Kantian ideological/deontological ethical code can be reduced to a set of basic rules from which the robot can produce new ethical rules suitable to face new circumstances. Kantian ethics states that moral agents are both rational and free. But, as argued by many authors, embedding ethical rules in a robot agent naturally limits its freedom of thought and reasoning.

In [14], *Shibata, Yoshida and Yamato*, discuss the issue of using robotic pets in therapy of the elderly via some level of companionship. They discuss as a good representative example for this application the seal robot *Paro*, which has also been extended for use as part of therapeutic sessions in pediatric and elderly institutions world-wide [15].

In [16], *Arkin* summarizes the ethical issues faced in three realities, namely autonomous robots capable of lethal action, entertainment robots, and unemployment due to robotics. He argues that in the first reality (lethality by autonomous robots) the international laws of war and rules of engagement must be strictly followed by the robots. To assure this, the *Just War* theory should be understood, and methods should be developed and delineated for combatant/non-combatant discrimination. For the second area (personal robotics) he argues that a deep understanding of both the robot capabilities and human psychology is needed, in order to explore whether the roboticists’ goal to induce pleasant psychological states can be achieved. The third area concerning robotics and unemployment is of social concern since the time where industrial robots were put in action (in shipyards and other manufacturing environments). It is argued that a clash between utilitarian and deontological morality approaches should be followed in order to deal with both the industrial/manufacturers’ concerns and the rights of the individual workers.

In [17] *Huttunen* and colleagues discuss the legal perspective of responsible robots. Their work does not focus on ethical considerations, but on the legal liability risks related to inherently error-prone intelligent machines. A solution combining legal and economical aspects is proposed. To overcome the difficulties of creating perfectly functioning machines and the cognitive element inherent in intelligent machines and human-machine interaction a new kind of legal approach is developed (a financial instrument liberating the machine). In this way a machine can become an ultimate machine by emancipating itself from its manufacturer, owner, and operator.

In [18], *Murphy and Woods* have rephrased Asimov's laws (which they view as robot-centric) such as to remind robotics researchers and practitioners of their professional responsibilities. Asimov's laws placed in the scheme of morality levels mentioned in Sect. 2.1 [8], regard the robots to have functional morality, i.e., robots have sufficient agency and cognition to make moral decisions. The alternative laws proposed are more feasible to implement than Asimov's laws with current technology but they also raise new questions for investigation (see Chap. 5, Sect. 5.3).

In [19], *Decker* addresses the question of whether humans can be replaced in specific contexts of action by robots, on the basis of an interdisciplinary technology assessment. Adopting a "means-end" approach the following types of replacement are investigated: (i) technical replacement, (ii) economic replacement, (iii) legal replacement, and (iv) ethical replacement. The robots considered in the study are assumed to have advanced modern learning capabilities. Regarding autonomy levels the following levels are employed: (i) first-level (technical) autonomy, (ii) second-level (personal) autonomy, and (iii) third-level (ideal) autonomy. The conclusion of this study is that in a Kantian ethical perspective robot learning should be assigned as the responsibility of the robot's owner.

In [20], *Lichoeki, Kahn Jr. and Billard*, provide a comprehensive survey of a number of basic ethical issues pertaining to robotics. The question of whom or what is responsible when robots cause a harm is first discussed. Then, the ethical aspects emerging in lethal robots created to act in the battlefields, and in service robots are discussed. In all cases, investigators agree that they want robots which contribute to a better world. The disagreements are on how this could be achieved. Some people want to embed (and actually embed) moral rules in the robot controller, while others argue against this, asserting that robots themselves cannot become moral agents. Others explore the use of robots for helping children with autism or for assisting elderly. The questions addressed in the studies reviewed range from philosophical ones, and extend to psychological and legislation questions.

Two comprehensive books on lethal robot ethics are [21, 22], and three important contributed book chapters on related topics for autonomous learning and android systems are provided in [23–25]. Books on the general field of computer and machine ethics include [26–28]. Three recent books addressing machine, information, and robot ethics questions are [29–31].

In [26], an in-depth exploration and analysis of the ethical implications of widespread use of computer technology is provided bringing together philosophy, law, and technology. In [27] the wider field of computer/machine morality is

investigated including key topics such as privacy, software protection, artificial intelligence, workspace issues, and virtual reality. In [28] an anthology of 31 well-selected contributions is provided written by competent researchers in the field of ethics for machines. In [29] the ethical perspective considered, is the one that humans have when interacting with robots, including health care and warfare robotic applications and the moral aspects of human-robot cooperation. Finally, in [30] the question of machine moral agency is addressed, i.e., whether a machine might have moral responsibility for decisions and actions. The question whether a machine might be a moral patient legitimate of moral consideration is also investigated.

1.4 Outline of the Book

We have seen that roboethics is concerned with the examination and analysis of the ethical issues associated with the design and use of robots that possess a certain level of autonomy. This autonomy is achieved by employing robot control and artificial intelligence techniques. Therefore *roboethics* (**RE**) is based on three field components, namely: *ethics* (**E**), *robotics* (**R**), and *artificial intelligence* (**AI**) as shown in Fig. 1.1.

In practice, roboethics is applied to the following subfields that cover the activities and applications of modern society as shown in Fig. 1.2.

- Medical roboethics
- Assistive roboethics
- Service/socialized roboethics
- War roboethics

Based on the above elements (shown in Figs. 1.1 and 1.2) the book involves 12 chapters including the present chapter. Chapters 2–5 provide background material and deal with the fields of ethics, artificial intelligence, robotics, and roboethics in

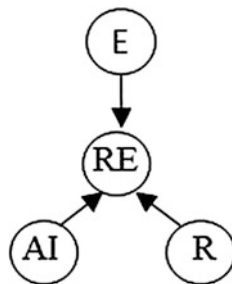
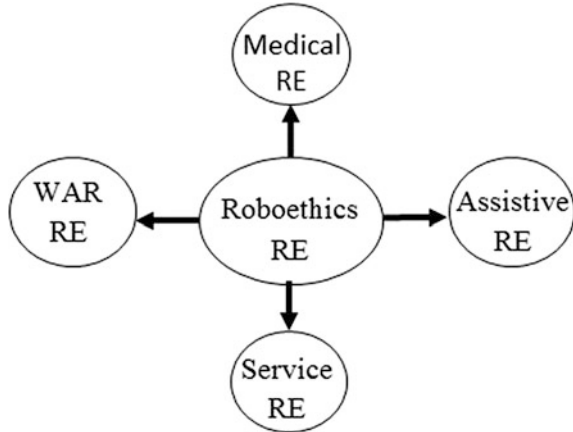


Fig. 1.1 Robotethics (*RE*) and its three contributing fields: ethics (*E*), robotics (*R*), and artificial intelligence (*AI*)

Fig. 1.2 The four principal areas of roboethics



general. Chapters 6–9 provide an exposition of medical, assistive, socialized, and war roboethics. Chapter 10 provides an overview of roboethics as conceived in Japan, and some intercultural issues concerning roboethics and infoethics. Chapter 11 discusses three further topics of roboethics, namely: autonomous (self-driving) cars, cyborgs, and privacy roboethics. Finally, Chap. 12 provides a short review of mental robots and their abilities.

The topic of the social and ethical implications of industrial robotics is fully discussed in most classical textbooks on robotics (e.g., [32, 33]). The principal critical issues of industrial robotics that concern the human individuals and society are:

- **Training and education** More well-educated robotics experts and operators are still needed. Most persons in the society either don't trust robotics or over trust it. Both are not good. Therefore people should be informed in a realistic and reliable way about the potential capabilities and risks of advanced robotics.
- **Unemployment** This was the most important issue of discussion two to three decades ago, but presently is at an acceptable equilibrium level due to increasing generation of new jobs.
- **Quality of working conditions** Working conditions are improved when robotics is used for jobs of the so-called three Ds, namely "*Dirty, Dangerous, and Dull*". Productivity increases may also, in the long term, result in a shorter and more flexible scheduled work week for the benefit of the workers.

The ethical aspect of robotics scientists for the unemployment should be of continuous concern. Robotics and automation engineers have the ethical duty to exert as much as they can their influence for social support for those potentially made unemployed. As for the working condition's quality the ethical duty of engineers is to develop the most efficient safety systems for human protection in all environments of robotics use, especially when the robots are in direct physical contact with humans. The outline of the book is as follows.