A Code of Ethics for the Human-Robot Interaction Profession

Laurel D. Riek
Dept. of Computer Science and Engineering
Robotics, Health, and Communication Lab
University of Notre Dame
lriek@nd.edu

Don Howard
Reilly Center for Science, Technology, and Values
Department of Philosophy
University of Notre Dame
dhoward@nd.edu

Abstract
As robots transition into human social environments, a new range of technical, ethical, and legal challenges are arising. This paper discusses the unique ethical challenges facing HRI practitioners designing robots for these spaces, and proposes a code of ethics for the profession. We argue that the affordance of all rights and protections ordinarily assumed in human-human interactions apply to human-robot interaction, and discuss various social, legal, and design considerations to facilitate this.

1. Introduction

Robots are rapidly transitioning into human social environments (HSEs), interacting proximately with people in increasingly intrusive ways (Riek, 2013). This transition presents a new set of technical, ethical, and legal challenges never before seen in the field. While the literature sufficiently addresses the technical challenges, human-robot interaction (HRI) practitioners are in need of practical guidance toward understanding the ethical and legal ones. (Herein, "HRI Practitioners" includes robotics researchers, designers, engineers, product managers, and marketers, working in industry, academia, or government.)

Some HRI practitioners receive guidance on these ethical and legal challenges through the support of their institutional review boards (IRB). However, even a thorough level of IRB review fails to guarantee that practitioners will be aware of all the relevant considerations as they explore the deployment of their technology. Furthermore, in the United States, the majority of consumer robots developed in industry require little (if any) ethical oversight before they are sold. Thus, the need for a code of ethics for HRI practitioners becomes ever more compelling, as does its endorsement by relevant professional associations, this a way of encouraging at least a minimum of attention to ethical issues.

Nourbakhsh (2013) calls on roboticists to develop a code of ethics; Ingram et al. (2010) have proposed a general code of ethics for robotics engineers. We propose both to focus the effort more narrowly by emphasizing the unique ethical challenges of robots in HSEs, and to broaden the effort by extending the scope of the proposed code beyond the research setting to also be applicable to HRI practitioners serving in non-research roles. We also emphasize the unique challenges posed by ever greater robot autonomy.

In what follows, we review various examples of settings in which distinctive ethical issues arise in HRI research, development, and marketing where explicit guidelines would be appropriate. We then turn to a preliminary sketch of proposed principles for an HRI code of ethics.

2. Ethical Challenges in HRI Research, Development, and Marketing

The following list of examples is meant to be illustrative of the distinctive ethical challenges arising in HRI research, development, and marketing. It is by no means exhaustive. Note, in particular, that we deliberately avoid, for the purpose of this discussion, scenarios popular in science fiction, such as the "Terminator" series, "I, Robot," "Battlestar Galactica." We do this for the reason that focus on such robo-dystopias draws attention away from the more mundane but, therefore, more important ethical challenges that confront ongoing, everyday, HRI work. We also deliberately avoid for now challenges related to the development of ethics capabilities in robotic systems, themselves, while recognizing that this issue will require considerable attention in the near future, given the increasing and ever more widely recognized need for ethics programming in artificial systems ranging from autonomous weapons systems to self-driving cars (Wallach and Allen, 2009; Anderson and Anderson 2011; Arkin 2009).

For the purposes of this article, we assume that robots are embodied systems capable of directly enacting physical change in the world. We are not referring to disembodied intelligent agents, like autonomous stock trading programs, but technologies with effectors that either move the robot (i.e., locomotion) or move objects (i.e., manipulation). The ethical issues we discuss are generally applicable to all robots in HSEs, regardless of their level of autonomy, their role, their capabilities, or their morphology.

2.1 Therapeutic Robots

HRI practitioners often deploy robots in therapeutic settings with vulnerable populations; for example, to help treat children with autism spectrum disorders (Scassellati, 2007; Feil-Seifer and Matarić, 2009; Diehl et al., 2014), to reduce stress and encourage pro-social behavior among older adults (Kidd et al. 2006, Wada and Shibata, 2007), and to help children with developmental disabilities (Kozima et al., 2008; Drane et al., 2009). However, HRI practitioners who work in this area often discuss some of the downsides to their work, specifically: what happens when the project ends and the robot goes away?

These therapy recipients can often develop strong psychological and emotionally important bonds with the robot, the severing of which at the end of a project can have serious harmful effects on the subject, perhaps negating any therapeutic benefit the subject might have experienced or even leaving the subject in worse condition than before the research began. Accordingly, any HRI research must be required to address the risks and benefits for the human subjects associated with the termination of the research program, with protocols being specified in advance for addressing any consequent needs on the part of the subject.

2.2 Physically Assistive Robots

In a similar vein to therapeutic robots, robots intended to provide physical assistance to people with disabilities presents a unique set of ethical challenges to HRI practitioners. Robots may be used for daily living tasks, such as bathing (King et al., 2010), manipulation (Tsui et al., 2008, Jain and Kemp, 2010; Chen et al. 2012), mobility (Carlson and Demiris, 2008; Goil et al., 2013), and other activities to support independent living and aging-in-place (Forlizzi et al., 2004; Rantz et al., 2005; Beer et al. 2012).

Human clients in such settings constitute a vulnerable and dependent population whose physical and psychological needs must be respected in HRI design and implementation. Specific areas of potential concern include: (a) the involvement of robots in particularly intimate activities such as bathing and sanitation; (b) direct physical contact between robots and humans, as in lifting patients in and out of beds and wheelchairs; and (c) the high probability of patients' forming emotional bonds with robots in environments otherwise sometimes comparatively lacking in human companionship.

The design of physically assistive robots must, therefore, take into consideration the privacy rights of clients, as with, perhaps, the deactivation of video monitors during intimate procedures. Care must be taken with protocols for touching, something that is a standard part of human caretaker training in such facilities.

Furthermore, HRI practitioners should consider whether these robots be designed to encourage or discourage the formation of emotional bonds, while realizing some bonding will be inevitable regardless of the morphology of the platform (Forlizzi and DiSalco, 2006; Riek et al. 2009; Scheutz, 2011; Carpenter, 2013).

2.3 Robot Interrogators

As more social robots are marketed and human-robot interaction becomes more frequent and occurs across a wider array of settings, an ever more common role will be that of the robot interrogator, with robots functioning as sales agents, conflict resolution intermediaries, and similar roles. In such settings, notions of "informed consent" or "implied consent" become ever less relevant as the preferred tool for managing risk.

While one might reasonably expect patients in a nursing home setting, or their legal guardians, to grant such consent, this will not even be feasible with the routine deployment of robots as sales agents in commercial settings, especially in those cases where the human customer has no option to secure needed service otherwise than through interaction with a robotic agent. As Calo (2012) points out, such interactions raise questions about risks like unintended information disclosure, the information then being used for commercial purposes. Accordingly, the burden for managing risk shifts ever more from the human to the HRI practitioner.

2.4 Turing Deceptions from Improper Wizard-of-Oz Use

HRI practitioners frequently use Wizard-of-Oz (WoZ), a technique where a person (usually the practitioner) remotely operates a robot and puppeteers many of its attributes (speech, non-verbal behavior, navigation, manipulation, etc). WoZ may involve multiple degrees of control, as well as mixed initiative interaction (Riek, 2012).

Many researchers have raised ethical concerns about WoZ and its inherent social deception. Fraser and Gilbert (1991) express concerns about the embarrassment participants feel after they learn they were deceived. Riek and Watson (2010) and Miller (2010) discuss the problems with "Turing Deceptions", where a participant cannot determine if they are interacting with a machine, a specific person, or a person masquerading as another person. The EPSRC, the major research funding agency in the UK, included a specific WoZ provision in its ethical rules, stating that users should always be able to "lift the curtain" on a WoZ interaction, because robot intelligence remains an illusion (EPSRC, 2011).

Thus, HRI practitioners must be especially careful in their use of WoZ, particularly among vulnerable populations. Riek (2012) provides detailed means for how to ensure this in HRI research through the use of rigorous experimentation; HRI practitioners outside the research community should also consider these guidelines in their work. For example: How will WoZ be used, and what will be wizard controller? What will be disclosed to people interacting with the robot, and at what point during the interaction? Can people opt-out? What happens when the link goes down between the robot and the wizard?

Another issue to consider with WoZ use is the problem of fostering inappropriate expectations among people interacting with the robot. A number of researchers have explored how robot morphology and functionality affects expectation setting in HRI contexts (Powers et al., 2003; Hinds et. al 2004; Lohse, 2011, 2012). However, it is equally critical HRI practitioners consider how WoZ use of a robot's social behavior might affect expectation setting. This also ties into the aforementioned issues of bonding to robots, as well as trust (Hancock et al., 2011; Desai et al., 2012; Mason et al., 2013).

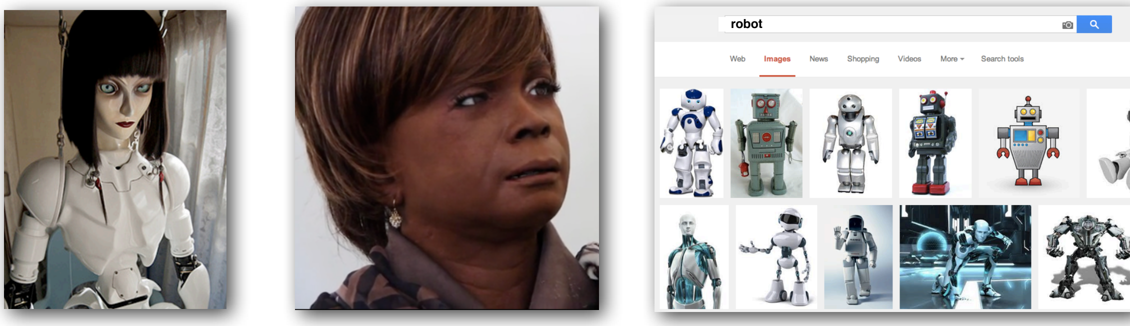

Fig. 1. From left to right: (1) The fembot robot morphology, frequently favored by designers of humanoid platforms (2) Bina86 robot, one of the few gynoids of color; (3) An image search for "robot", depicting that the majority of common robot designs are grey, boxy, and masculine. (*Photo Credits: Rene Walter, Love Machine, Google).*

2.5 Lack of diversity in robot morphology and behavior

There are a variety of other settings in which ethical questions about the selection of robot morphology and behaviors arise; particularly regarding manifestations of gender, race, and ethnicity. A widely discussed example is fembots in Japan, where questions have been raised regarding the over-feminization of the platforms (Robertson, 2010; Draude, 2011). In terms of race, with precious few exceptions, such as Hanson's Bina48, the vast majority of android and gynoid robots are Asian or Caucasian in their features for no discernible reason. Furthermore, most of these robots tend to have a euro-centric design with regards to their appearance, behavior, and voice. (See Fig. 1).

Another issue concerning diversity of platforms is that many mechanistic robots conform to Hollywood-driven stereotypes: grey, boxy, masculine. Since one of the ultimate goals in HRI is to aim for broad user acceptance of robots, it may behoove designers to explore alternate platform morphologies. For example, Sirkin and Ju (2014) have been exploring the design of expressive everyday objects, and Sabanovic et al. (2014) propose unique prototyping methods for designing novel, socially situated embodiments.

2.6 Human-Robot Handoffs and Shared Autonomy

With the anticipated, rapid introduction of self-driving cars and other automated control systems in human environments, an ever more important form of human-robot interaction will be handoff of control from robot to human controllers at various points of operation (See Fig. 2). In the HRI research community, these handoffs of control are often discussed in the context of instrumenting shared autonomy (Miller and Parasuraman, 2007; Humphrey et al., 2007; Kulić and Croft, 2005; Wilcox et al., 2013) and designing for acceptability (Takayama et al., 2011; Strabala et al., 2013). However, these handoffs also present a variety of design challenges that implicate ethical considerations.

These considerations range from design decisions about the kinds of situations in which robot-human handoff will be suggested or mandated, to designing for ease of handoff without significant interruption of control functionality, and designing for avoidance of unwarranted human operator habituation to automatic controls. A dramatic way to put the last point is that one does not want the human operator to be asleep at the wheel if and when handoff is required (e.g., considering neglect curves as proposed by Goodrich et al. (2001)). Thus, one should design automated controls that require occasional human inputs as well as preplanned episodes of handoff to the human controller for the purpose of maintaining human control skill levels (Form, 1987).

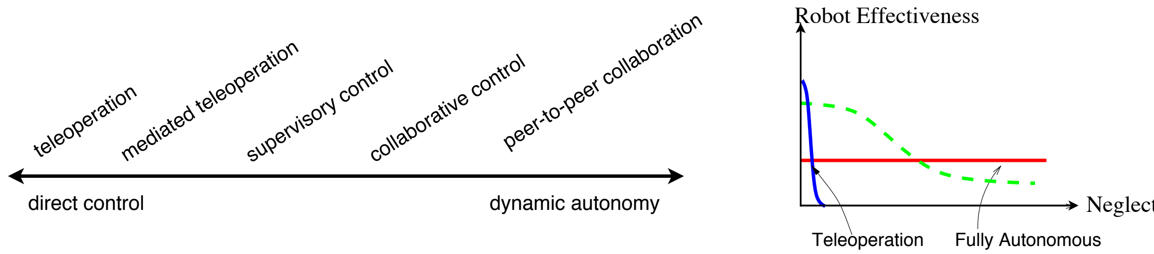

Fig. 2. On left, an autonomy scale with various levels of human intervention (Goodrich and Schultz (2007). On right, the neglect curve, depicting the relationship between user attention and robot autonomy (Goodrich et al. (2001)). As the number of tasks or the number of robots increase in complexity, a robot is less effective the more it is neglected. (*Images used with permission.)*.

A still greater challenge comes in the form of deciding whether robot-to-human handoff will be standard in situations calling for explicit moral judgment on the part of the controller, as with standard "trolley-problem" scenarios,[1] or whether a capacity for such judgment will be designed into the automated control systems, themselves.

3. Guiding Principles for an HRI Code of Ethics

Given the speed with which robotics technology advances, ethical challenges such as these will continue to multiply. Thus, there is a clear need for explicit consideration of ethics in HRI research, development, and marketing. The general public and professional ethicists will surely have input, but it would be best if attention to HRI ethics began within the practitioner community in order to facilitate the incorporation of ethical perspectives in every phase of HRI research, development, and marketing. One wants to avoid as much as possible situations in which ethical problems are noticed only after the fact. One also wants to discourage the idea that ethics is a form of expertise wholly detachable from scientific, engineering, and business practice. One especially wants to avoid giving the impression that it is the responsibility of the ethicist to instruct scientists and engineers on what they may and may not do. Ethics should, instead, be understood as making a constructive contribution to work in HRI. The following, suggested, guiding principles are, therefore, intended mainly for the practitioner audience.

Note that we focus our attention here on the impacts of HRI on humans. We deliberately avoid, for now, all questions about the ethics of human treatment of robots, recognizing that those questions will have to be addressed in a future, more comprehensive treatment of HRI ethics.

3.1 The Prime Directive

All HRI research, development, and marketing should heed the overall principle of respect for human persons, including respect for human autonomy, respect for human bodily and mental integrity, and the affordance of all rights and protections ordinarily assumed in human-human interactions. The robot actor is expected to behave in a manner at least as respectful of human personhood as human actors to the extent feasible.

[1] The "trolley problem" is the conventional philosopher's name for a dilemma in which an agent must decide whether passively to allow a greater harm to occur or actively to cause a lesser harm in order to prevent that greater harm. Such examples are already discussed in the literature on self-driving cars (Lin 2013).

3.2 Specific Principles

Human Dignity Considerations

(a) The emotional needs of humans are always to be respected.

(b) The human's right to privacy shall always be respected to the greatest extent consistent with reasonable design objectives.

(c) Human frailty is always to be respected, both physical and psychological.

Design Considerations

(d) Maximal, reasonable transparency in the programming of robotic systems is required.

(e) Predictability in robotic behavior is desirable.

(f) Trustworthy system design principles are required across all aspects of a robot's operation, for both hardware and software design, and for any data processing on or off the platform.

(g) Real-time status indicators should be provided to users to the greatest extent consistent with reasonable design objectives.

(h) Obvious opt-out mechanisms (kill switches) are required to the greatest extent consistent with reasonable design objectives.

Legal Considerations

(i) All relevant laws and regulations concerning individuals' rights and protections (e.g., FDA, HIPPA, and FTC) are to be respected.

(j) A robot's decision paths must be re-constructible for the purposes of litigation and dispute resolution.

(k) Human informed consent to HRI is to be facilitated to the greatest extent possible consistent with reasonable design objectives.

Social Considerations

(l) Wizard-of-Oz should be employed as judiciously and carefully as possible, and should aim to avoid Turing deceptions.

(m) The tendency for humans to form attachments to and anthropomorphize robots should be carefully considered during design.

(n) Humanoid morphology and functionality is permitted only to the extent necessary for the achievement of reasonable design objectives.

(o) Avoid racist, sexist, and ableist morphologies and behaviors in robot design.

4. Discussion

In the robot ethics literature, Isaac Asimov's laws of robotics (Asimov 1942) have so dominated discussion about the ethics of human-robot interaction as to eclipse the fact that day-to-day ethical challenges facing HRI research, development, and marketing. But these ethics questions are significant, and full attention to them will be required both in order to ensure more responsible practice within the HRI community and public acceptance of the technologies produced by that community.

In other words, it is in the interest of HRI practitioners to take ownership of HRI ethics issues and to make attention to those issues a routine aspect of their everyday work. A culture of ethical awareness and sophistication within the HRI community will, thus, advantage the cause of HRI research, development, and marketing.

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