

Code of Ethics for Robotics: A Surgery Case Study

Griffin Almand

Abstract

The future of robotics is broad and varied. New developments that delve deeper into the use of artificial intelligence and automation, for practices ranging from driver less cars to doctor less surgeries, calls for a defined code of cultural, ethical, and legal regulations that can guide engineers around the most delicate issues that may arise. With the reputation of the field resting on the evolution of a code of ethics this paper compares and discusses existing literature on the subject. With the foundation and influence of the existing literature this paper proposes a refined code of ethics designed to target the specific area of robotic engineering. It is also designed to remain applicable for future developments in the field. Having laid out the code it is then be applied to a case study focusing on surgery robots. Final recommendations and conclusions are made to advise future developments for an ethical code targeted at robotic engineers.

Keywords: Robotics; Ethics; Automation; Review; Surgery.

1. Introduction

Robots are programmable machines that have, through massive technical developments in a small amount of time, a much higher degree of autonomy than they did twenty years ago. This increase in functionality has sparked a lot of research and expansion into the potential for robots and how they can 'improve' the lives of humans. The global market for robots is also growing rapidly, the market for industrial robotics was estimated to be worth about 43.8 billion U.S. dollars in 2021. The same market is expected to be worth almost 70.6 billion U.S. dollars by 2028 [1]. With such a substantial industry on the rise it is important to establish a reliable code of ethics that will protect and enhance the reputation of the sector.

A code of ethics, defined by Investopedia, is a guide of principles designed to help professionals conduct business honestly and with integrity. A code of ethics or ethical code can cove a range of areas from employee codes of conduct to, the more relevant for this paper, codes of professional practice and business ethics [2]. Codes of professional practice are self-explanatory; they detail, in this context, guidelines that engineers can follow or reference to ensure that they are working in a moral and honest way. Business ethics are the study of acceptable business policies and practices regarding morally controversial areas such as corporate governance, insider trading, bribery, discrimination, corporate social responsibility, and fiduciary responsibilities [3].

1.1. Objective

The objective of this paper is to gain an understanding of what is currently being done by engineers and academics to establish and maintain a proper code of ethics around the industry of Robotics. This study comments on where this code of ethics succeeds and where it may fall short as well as the longevity of such guidelines in an industry that has not yet reached its full influence. Recommendations, where possible, of what could be improved or added to this code will also be included.

This paper reviews multiple pieces of literature about ethics around the field of robotics. The information from these reviews are collated into a useable code to evaluate a specific case and study the impact and importance of ethics for a specific example in the Robotic Industry.

2. Literature review

The following section investigates pre-existing explorations around ethics in the field of robotics. A brief overview of each piece of literature will be given before a closer look at the content of the piece is examined. This section will build a decent framework of background knowledge that can be used to establish a code of ethics.

2.1. Ethics/Sustainability issues

2.1.1. A Code of Ethics for Robotics Engineers (2010)

The undergraduate students at the Worcester Polytechnic Institute, that published the paper, *A Code of Ethics for Robotics Engineers*, investigated existing codes of ethics for engineers. In their report the authors highlight where these codes weren't specific enough for the future developments of robotics or where they left out critical ideas relevant to the field; an example they noted was how '*none of the existing codes examined, call upon engineers to take responsibility for the actions of their creations, i.e., robots.*' From these observations they developed and refined a new set of guidelines that was more directly targeted at robotic engineers. The authors also explain that they conducted research with focus groups and distributed an ethics survey to robotics engineers at the Robotics Innovation Competition and Conference to better encourage the broader acceptance of their new code of ethics. At the end of the paper the code of ethics agreed on by the group is listed and includes their future steps [4].

The motivation for this 2010 paper is very similar to that of this report. The authors were tasked with reviewing current codes of ethics around engineering and update and iterate them so that they were applicable to the specific field of robotics. The first principle presented in their code was most interesting as it suggests that the engineer be held responsible for the actions of uses of all their creations. This would be pertinent in the case of malfunctions or situational errors in surgery robots and other automated robots. It is, however, integral in robotics made for use in wars as it puts all the responsibilities of how the creation is used back on the engineer, a situation reminiscent of the 1945 Atomic bomb and how it's use made people questioned the moral and ethical responsibilities of creators regardless of which third party, or army, is operating and/or controlling the creation [5].

2.1.2. Ethics in Robotics and Automation: A General View (2018)

The journal article *Ethics in Robotics and Automation: A General View*, takes a step further than the previous paper in its discussion on what it calls roboethics - robotic ethics. Instead of focusing solely on the ethics of making and engineering robots Tzafestas, the author, also investigates the code of ethics a robot itself should abide by; Tzafestas even asks the question, '*Could a robot be ethical?*'. The article presents thirty questions on the ethics of robotics which Tzafestas uses to form a foundation for the future building of an ethical code for the field of robotics and automation. Tzafestas defines seven branches of roboethics. These branches were: medical and healthcare roboethics, ethics of assistive robots, ethics of social robots, Autonomous vehicle roboethics, War/Military roboethics, Cyborg ethics, and Automation Technology ethics [6].

The direction this article takes with its questions of robot morality is interesting and builds further upon the idea of responsibility noted in the first paper. The way this paper frames that concept is interesting because it suggests that an engineer is not only

responsible for working and acting in an ethical way but are also responsible for imbuing an ethical code of conduct into their creations. The idea of a robot's ethical code in this article have been the topic of a lot of science fiction literature and film; the relationship between the robot and the engineer in this article bears comparisons to Frankenstein and his monster for example, the ethics of creating intelligent 'life' and the importance of the creator is similar in both works. With such an extensive history in pop culture and influence over the public perception of robotics and robotic engineering it is important to include robot ethics in an ethical guide for engineers, especially when considering artificial intelligence and automated vehicles.

The article also defines some notable areas of roboethics. The branches of medical, assistive, and social roboethics are particularly interesting as they deal with interaction between robots and humans in a far more significant way than the other branches like autonomous vehicles and automation technology. Medical, Social, and Assistive are person to person services like, surgeons, doctors, counsellors, and carers. This raises not just important ethical questions but societal issues as well, are humans going to like being in a position where a robot has power over them? Are there ethical issues with a robot having power over a human? A good code of ethics should include principles which answer these questions.

2.1.3. Ethics of Artificial Intelligence and Robotics (2020)

The article *Ethics of Artificial Intelligence and Robotics* takes a, philosophically framed, view on the ethics of robotics and artificial intelligence. Müller identifies how new technological developments always generate 'concerns' ethically and in societal opinion, he states the task of this article is to "*analyse the issues and to deflate the non-issues*" raised in these concerns. Müller branches into different areas of roboethics like Tzafestas; these branches are Human-Robot Interaction, Automation and Employment, and Autonomous Systems. In each of these sections Müller describes what each branch is and a few of the common issues, he then gives one or two specific examples to focus on and discuss the specific issues these examples present. Müller also looks at the idea of ethical machines and progressively "*Artificial Moral Agents*" an idea that suggest robots be allocated responsibilities and be given rights in society [7].

Throughout the article the author often refers to duties and attributes of robots as fake, false and artificial. This presents an interesting argument in the foundation of an ethical code for robots. An example Müller gives is artificial care, presenting the argument that the 'care' from an assistive or medical robot is not genuine. To play these emotions and qualities off an empathetic being such as humans can be considered deceptive, wrong, and possibly unethical.

In the article Müller defines a problem as when "*we do not readily know what the right thing to do is. In this sense, job loss, theft, or killing with AI is not a problem in ethics but whether these are permissible under certain circumstances is a problem.*" This passage is of particular interest because it seemingly goes against the principle highlighted in the first text which said that an engineer is responsible for the actions of its creation. This paper suggests that it is the responsibility of the person in control of the robot to have it perform its actions in an ethical way. Indeed, Müller goes on to write about military robots, "*Arguably the main threat is not the use of such weapons in conventional warfare, but in asymmetric conflicts or by non-state agents, including criminals.*"

3. Code of ethics/sustainability

Using the literature in the previous section as a framework, and developing further the ideas that were discussed, a code of ethics can be written up that is directed at Robotics engineers.

3.1. Recognise that as a Robotics Engineer I can be held responsible for the impact of society caused by any of the creations in which I have a part.

It is the responsibility of the robotic engineer to consider all possible uses for their creation and decide whether it is ethical and right to pursue the development or not.

3.1.1. I may not be held responsible for the actions of all the creations in which I have a part if control is relinquished to an external party.

At the point where control and oversight of the creation is passed on to an external party, this meaning the engineer no longer has the power to make decisions, the burden of responsibility shifts from the engineer to the company that buys or accepts the creation.

3.2. Understand that the passing of robot control to an external party is, in most cases, my choice and, therefore, am at least partly responsible for the choosing who can use the robot.

While an engineer can't necessarily control how a person may use their creation what is under the engineer's control is who they produce the robot for. This means an engineer is responsible for ensuring that they choose clients or contracts which promise the most ethical use of their creation.

To summarise (3.1, 3.1.1, 3.2) an engineer is responsible for what they choose to make they are responsible for who they sell it to, but they are not directly responsible for how that party use the creation.

3.3. Recognise that Robots of my creation should be designed for Human supervision and, therefore, should not operate or report in ways beyond human understanding

In situations where robots can be designed to replace a human at a task and in a more general situations involving Human-Robot Interaction an engineer's creation should also be designed to be supervised by a human expert. This means the creation needs to be able to report and justify all its decisions and actions in a comprehensible form for humans.

3.4. Understand that intelligent creations in which I have a part should have a basic code of ethics, like what is expected of humans, as a default directive for its decision making.

When programming a robot or other intelligent creation an engineer is responsible for imbuing and including a basic code of ethics that influences the robot's decision making.

3.5. Recognise that the intelligent creations in which I have a part should be able to justify each "ethical" decision they make, and/or ask for clarification from a human supervisor if its ethical programming produces conflicts.

Like 3.3 a robot should be able to justify every ethical decision it makes and display a clear reasoning for its actions.

3.6. Accept that any persons have the right to refuse any type of service or help from a robot of my creation.

As is the case with medical attention any human being has the right to refuse the services or help of a robotic or 'artificial' creation. This ensures humans human rights aren't impacted negatively.

3.7. Understand that it is my duty to not knowingly misinform people, and if I recognise misinformation is being spread, I will do my best to correct it.

It is the ethical duty of a robotics engineer to always remain trustworthy and not intentionally misinform customers, employers, colleagues, or the public in any way. It is also a robotics engineers' ethical duty to correct any misinformation spread by others.

3.8. Wherever applicable I and the creations in which I have a part should respect and follow local, national, and international laws.

A robotics engineer and their creations must abide by the laws of the communities they are made in and will be used in.

3.9. Recognize and disclose any conflicts of interest in my professional field.

To ensure a robotics engineer is acting ethically they must disclose the existence of any conflicts of interest to employers.

3.10. Accept and offer constructive criticism in my professional field.

To ensure that the field of robotics engineering is and remains unbiased it is the duty of an engineer to be able to give and receive feedback including criticism across their field.

3.11. Understand that where possible I should help and assist colleagues in their professional development and in following this code.

This code is important for the reputation of the entire robotics engineering field and therefore, it is important that engineers help others in the field follow it and learn how to act ethically as a robotic engineer.

4. Case study discussion

Having established a code of ethical guidelines for the use of robotic engineers, the next section applies this guide to an example based in the real world.

In recent years the practicality and convenience of robotic surgery have come to the fore. The benefits of a system which provides surgeons with a greater degree of accuracy and control while leaving patients with less lasting signs of the procedure are obvious and justify the research and developments being done across the globe. However, there is some concern whether giving more control to a robot surgeon is ethical. Currently in the field surgery robots fit into three main categories: controlled systems that depend entirely on a surgeon's actions, translating them into precise movements; automatic systems that perform surgery directly after being programmed by a surgeon or other human operators; and semi-automatic systems that constrain a surgeon's movements [8].

The surgical robots in practice today are far from being the autonomous decision making, replacements for Human doctors that would truly challenge the field of ethics and engineering. However, it could be interesting to examine a few principles from the code of ethics presented in this paper in terms of a broader definition of surgery robots that allows for growth and new development in the industry. The Da Vinci systems surgical robot will be used as a baseline for the application of the code of ethics. This creation assists a human surgeon by giving the surgeon control over systems that are more accurate than a human on their own [9].

4.1. Recognise that as a Robotics Engineer I can be held responsible for the impact of society caused by any of the creations in which I have a part.

In this case of surgical robots this could be a good thing as it can help a lot of people and improve the success rate of difficult surgeries. However, it could also be negative if the robot doesn't improve upon the current system and causes more harm than good.

4.1.1. I may not be held responsible for the actions of all the creations in which I have a part if control is relinquished to an external party.

Medical malpractice of the robot, particularly one such as the Da Vinci systems robot, is still the responsibility of the human surgeon in attendance. When the robot is presented to a hospital or medical institution the responsibility of its actions moves from the engineer to the institute or buyers.

4.2. Understand that the passing of robot control to an external party is, in most cases, my choice and, therefore, am at least partly responsible for the choosing who can use the robot.

An extreme example of this would be a company purchasing the robot for the purpose of the illegal harvesting human organs or performing illegal surgeries.

4.3. Recognise that Robots of my creation should be designed for Human supervision and, therefore, should not operate or report in ways beyond human understanding

This is fine for the Da Vinci systems robot as it requires a human to operate however further developments would need to be able to take and filter real time instructions and advice from human experts.

4.4. Understand that intelligent creations in which I have a part should have a basic code of ethics, like what is expected of humans, as a default directive for its decision making.

A more advanced version of a surgical robot would need to be programmed with the foundation for its decision making routed in the extensive ethical code for doctors and surgeons. An artificial hypocritical oath if you will.

4.5. Recognise that the intelligent creations in which I have a part should be able to justify each “ethical” decision they make, and/or ask for clarification from a human supervisor if its ethical programming produces conflicts.

This is quite important for the application of surgical robots. If a surgery goes wrong, which is always a possibility with surgery, then the robot should have a way of reporting its decision-making process clearly and concisely so that a supervising human can understand how and why the robot took each step that it took.

4.6. Accept that any persons have the right to refuse any type of service or help from a robot of my creation.

Just like how a person can refuse medical attention if they want to, it should be expected that a person should be able to refuse the attention of a surgical or medical robot for whatever reason.

The other principles in the code of ethics, listed below, are more general and directed at the ethical behaviour of an engineer. For more information and context around these principles see section 3.

5. Conclusion and recommendations

The field of robotic engineering is a predicted to have massive growth over the next ten years, and beyond. The lack of any defined code of ethics risks the reputation of the entire field as engineers have no guidelines to follow around difficult and sensitive issues. A notable exclusion in this report is Asimov’s three laws of Robotics. These three laws were devised by Isaac Asimov with the idea of guarding against potentially dangerous artificial intelligence and are popular in discussions around the ethics of robots. The three laws are: A robot may not injure a human being or, through inaction, allow a human being to come to harm, A robot must obey orders given it by human beings except where such

orders would conflict with the First Law, and A robot must protect its own existence if such protection does not conflict with the First or Second Law. The reason these laws were omitted was because there is very little evidence that these laws could work for intelligent AI [10].

The process of compiling a code of ethics that is both practical and future proof requires an extreme amount of research far beyond the scope of this paper. Teams of engineers, ethical experts and philosophers need to review and debate large issues such as the ethical nature of voluntary amputation to swap a functioning body part for cybernetic one and if creating intelligent robots is just perpetuating the tradition of slavery and exploitation. There is much to discover and discuss and not just around the ethics of robotic engineering but also what system of ethics an intelligent machine should conform to and what rules it needs to follow to be sustainable and ethical in society. The size of the field and variations in its subbranches, which each have their own issues for ethical considerations, makes this a difficult task. Smaller research and contemplation contained in material such as this report, and the other articles reviewed in this paper, are an integral tool in the foundation of a code of ethics for robotics engineers as they test the waters and start discussions across the field, and beyond, on what should be accepted and what should not.

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