

# GENERAL AWARENESS OF ROBOT ETHICS: A CASE STUDY OF JORDANIAN MECHATRONICS ENGINEERING STUDENTS

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**Abstract** - Robots have recently invaded our lives. Despite being indispensable tools, weaved into the fabric of our daily lives, they have introduced many ethical and social aspects. Nonetheless, the literature review shows that the awareness of robot ethics amongst engineering students has not been sufficiently investigated. Therefore, this study aims to investigate the awareness of engineering students to robot ethical issues and elicit their responses to ethically related problems. A semi-structured interview, showing some scenarios that involve a risk of robots interfering into people's lives in an unrestrained way was conducted on 50 Mechatronics engineering students at Philadelphia University, in Jordan. Results revealed students' lack of sufficient knowledge about robot ethics; their responses did not indicate a clear conceptualization of robot ethics. After been provided with detailed information about robot ethics, the participants reveal some concerns and offer some suggestions on how to embody ethics in robotic design considering issues relating to privacy, safety and the security of humankind. The present study opens up new avenues for future research to be conducted to further assess students' ethical awareness and behavior.

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**Keywords** - Ethical Applications, Mechatronics Engineering Students Robots, Robot Ethics

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## I. INTRODUCTION

Robots have recently invaded our daily lives [1-2]. They have become inseparable parts of our homes, schools, and hospitals. In spite of their advantages, they have introduced many disadvantages including the ethical concern. Due to such disadvantages, numerous studies were conducted to explore robot ethics [3-7]. Three broad interconnected ethical and social aspects are reported concerning robotics [8-10]. The first crucial aspect is safety particularly misrecognition by battle and security robots against hacking. The second one, which concerns law and ethics, includes programming codes of ethics into robots, comradeships between humans and robots as well as accountability of robot conducts. Besides, the social influence of robots specifically economical and psychological change of the society life style. Robot ethics exclusively relate to the robots' in-built ethical systems, the ethics of people that robot ethics should consider, those who design and utilize robots, in addition to ethical relations amongst individuals and robots [11].

## II. STATEMENT OF THE PROBLEM

The study is anchored in the field of robot ethics which is concerned with the application of ethical principles to robotic performance. Robot ethics are vital in every area where robotic applications are applied: healthcare, military, households, social care, industry etc. Integrating ethics into the discipline of robotics is a great issue that ethics scholars along with roboticists are concerned about [12]. Ethics become a necessity since robots are designed to communicate with humans not only with experts but also with many every day users such as children,

patients, elderly people etc. [13]. They are increasingly surrounding us in all walks of life; professional lives and even in our private sphere. The unidentified and possibly considerable harms and benefits and the risks and opportunities robots represents to social, cultural, and material life warrant instantaneous and cautious ethical consideration. Thus, engineers should take into account these potential risks and users' privacy when programming their robots due to their huge pervasiveness and intrusiveness in people's life. Their massive diffusion in recent and years to come might pose threats on individuals' privacy such as those used for surveillance, access and social applications [14]. The present literature on robot ethics offers appropriate frameworks to tackle these concerns [15-17]. Nevertheless, because ethical norms are not universal, there will not be one correct ethical design that could satisfy humanity as a whole [18].

Despite the fact that the significance of engineering ethics and their instruction are emphasized by the Accreditation Board of Engineering and Technology (ABET) [19] and National Academy of Engineering (NAE), ethics are not extensively considered in the undergraduate curricula and they are not even an obligatory stand-alone course [20]. ABET requires the broad education not only to comprehend the impact of engineering solutions in a global and societal context, but also to integrate ethics into engineering programs. This entails engineering students' understanding of professional and ethical responsibility [19]. The NAE requires that ethics education should foster students' ability to analyze multifarious decision situations and ill-structured problems [19].

Despite the fact that robot ethics are a very crucial and hot topic [18], very few studies have focused on

it [21-22]. The studies conducted mainly focused on people's general preferences of certain robot types and tasks specifically performed in domestic areas [23-24], the appropriateness of robots for various jobs [25] [22], the related fear, anxiety and safety issue of humanoid robots [23-24]. The literature review shows that the opinions of the engineers in many countries have not sufficiently been investigated from the perspective of robot ethics [2]. Veruggio and Operto [25] argue that without having the concept of robot ethics deeply rooted in society, the premises for artificial ethics' implementation in the robots' control systems will be lost.

### III. SIGNIFICANCE OF THE STUDY

The present research adds to the existing literature on robot ethics since it is the first study to consider a very essential concern regarding Jordanian engineers' awareness and conceptualizations of ethical issues. The addition helps in bridging the gap between roboticists and ethicists by introducing peoples' social implications and suggesting a solution to the concern of how to address ethical issues in the design of robots. This in turn could mitigate issues of societal concern regarding the design, development and implementation of robots in various fields. This is necessary due to the different conceptualisations and elucidations of the term robots ethics across countries due to having different social norms, opinions and attitudes toward robots with respect to different situations and influences [1], [26-28], [30-33], This in turn gives more insights and contributes to overall consensus of various robotics applications in different fields.

### IV. RESEARCH QUESTIONS

The present study endeavors to answer the following questions:

- To what extent are Jordanian Mechatronics engineering students aware of robot ethics?
- What are the ethical concerns of robots' widespread?
- What are their suggestions to embody ethics into robots?

### V. LITERATURE REVIEW

The potential of technologies namely Ambient Intelligence (AmI), Artificial Intelligence (AI), or Internet of Things (IoT) are being recognized by their wide application in pervasive environments were robots are widely used [34-45]. As expected by researchers in 2004, robots coexist with human beings, assist human beings both physically and psychologically and contribute to having safe and peaceful society. Though the revolution of robot offers promises for prosperous future, it raises broader ethical questions, one of which the breach of

privacy [36]. Robots automatic access to processing of personal information through collecting, analyzing, employing or sharing information besides their control over such processed personal information through seamless, dehumanized and occasionally invasive structures and opaque patterns raise privacy concerns as they have a disruptive impact on users' privacy [14], [37]. In a nutshell, Veruggio and Operto [28] summarise certain global ethical problems result from the relationship between humans and machines (robots). They highlight the good use and misuse technology, the anthropomorphization of the machines, cognitive and affective bonds between human and machines, technology addiction, socio-technological gap across ages, social layers, and world areas, fair access to technological resources, effects of technology on the global distribution of wealth and power as well as environmental impact of technology.

Robot ethics, a special branch of engineering ethics, encompass a general application of professional codes of conduct in robotics besides specific guidelines for human-robot-interaction. However, researchers in this field need to think thoroughly about the unpremeditated consequences, the ethics and legal problems that arise as a result of using robots. In other words, robots need to be safer carers and most importantly savers of life ([29]). Nonetheless, it seems that this issue is very complicated to be applied in a vast majority of fields [30-31]. This entails that the use of robots needs to be convincing to the vast majority of people including media and policy makers.

Their attitudes towards Robot ethics are ambivalent. Veruggio and Operto [28] classify them into three groups. There are those who are not interested in ethics as they consider robots' action to be strictly technical rather than social or a moral. There are also those who are interested in short-term ethical questions as they think of the good or bad sides of robots considering some cultural values and social conventions besides respecting and assisting humans in various areas. Finally, those who are interested in long-term ethical concerns they wonder whether the industrialized countries should not change their way of developing robotics as not to be more beneficial to the poor countries. Designing robot ethics necessitates the joint commitment of experts of numerous disciplines such as those working in transnational projects, committees besides considering people's opinions and perspectives to resolve problems resulting from the scientific applications of Robotics.

Veruggio and Operto [28] assert the codes of ethics of computer and information, the so called PAPA (i.e. Privacy, Accuracy, intellectual Property and Access). Privacy is normally described as a specific area of ethics [32],[41]. Privacy is concerned about the data about one's self or one's associations that an individual reveal to others and under what conditions

and with what protections. It is also about the things people can keep secret and not to be enforced to disclose to others. Accuracy stands for those that are accountable for the genuineness, loyalty and accurateness of information or the errors in information. Property refers to those who own information, the fair prices for its exchange, the channels through which information is transmitted as well as the way through which access to this scarce resource should be assigned. Ultimately, accessibility refers to what information does a person or an organization have a right or a privilege to attain and under what conditions and with what protections.

As an example, the code of ethics which was specifically designed for health and prepared at the —e-Health Ethics Summit<sup>2</sup>. The main principles of this code are candor, honesty, quality, informed consent, privacy, professionalism, responsible partnering, and accountability [33]. The experiment was done on using the wireless system monitoring the heart rate and the respiratory rate for home-visit rehabilitation strong data encryption was executed in the physical layer and approved by the hospital's ethics council, and patients and family [34].

## VI. METHODOLOGY

This is a two-stage explorative study. It mainly explores the Jordanian engineers' awareness and attitudes toward robots ethics. Students were exposed to some scenarios showing a jeopardy of robots interfering into the people's life in an unrestrained way. It investigates their imagination about the connection between both concepts \_robots' and \_ethics', the related ethical concerns of the widespread of robots in society. Realizing that the participants were not fully aware of the concept of ethics, the researcher went on the second stage which involved providing students with detailed information about robot ethics in order to elicit their suggestions to embody ethics into robots and solve any resultant problems. The semi-structured interview was the main tool used for collecting data due to its ability to elicit a wide variety of responses. 50 respondents were recruited from different academic years at Philadelphia University. The responses were qualitatively analyzed. They were classified based on themes.

## VII. RESULTS AND DISCUSSION

The results revealed that despite the importance of being aware of robot ethics, it has not been seriously and extensively taught at the university. This is evident in the lack of knowledge among the engineering students about ethics. The students' responses are not in agreement so as to show a concrete image of their conceptualisation of what is so-called robot ethics. the result reveals some of them revealed having no idea about what is called robot

ethics stating that "I know nothing about robot ethics" "I have no clue what so ever about this concept". On the other hand, it was ostensible that there was a sort of clash in other engineers' response. Some of the participants' definitions revolve around considering robot as a machine that follows orders and is devoid of any ethics or feelings "I think robots have no ethics as they do not have a brain like humans' to use it", "I cannot think of robot behaving ethically as they lack the emotions and sentiments". However, some others have a vague notion of having robot as a machine that should consider certain rules such as being helpful and not harmful to people and their environment "robots ethics are the rules that should be considered when using a robot for certain applications", "robots ethics are the conditions under which they can take actions<sup>l</sup>. Some other students define robot ethics by the way engineers program them or people deal with or use them either in a good or bad way as apparent in their responses "I think robots have no ethics unless the designers program them to have a few kinds of ethics but even though they will not be ethically competent<sup>l</sup>, "not under any condition, robots should be considered as humans simply because they are made by humans and controlled by human's programming, thus they may design them in the way they want by building in the ethics they need".

The engineering professional ethics of some of the participants were mostly an extension of their personal beliefs of ethics. This is apparent in their responses such as "robot is a machine that is programmed to support human in various sides of their life. It should carry the ethics of the person who made it; it should be safe", "robots have ethics as they should be programmed to store private data which should not be exposed (i.e. privacy)", "robot ethics are a short expression and reflection of people's ethics", "I don't have a clear idea of robot ethics by what came to my mind when I heard it that should be controlled by what is good for people and they should be designed to be noble machines.

Nonetheless, students' ability to apply personal beliefs of ethics and moral judgment about what is right and wrong does not assure that they are sufficiently educated about ethics. This designates that engineering teaching programs taught at university lack both precise and reliable ways of teaching professional ethics as well as proficient measurement methods. The robot ethics is neither taught as a full-fledged course rather it is introduced in few lectures on engineering nor assessed or graded. The instruction involves presenting short overview of robot ethics. This implies that our engineering students are not fully prepared to act professionally in their ethical performance in the workplace. In light of this result, the researcher recommends determining the essential elements that should be taught and the best ways through which they should be assessed. Students should not only be taught abstract ethical frameworks and moral justification but they should

also be exposed to ethical problems in very clear ways and be engaged in realistic engineering activities and cases where they are given a chance to apply their ethical awareness. In addition, motivational variables should be introduced and considered by engineering educators when designing robot ethics-based curricula because these motivational factors may greatly impact students' ethical awareness and envisage their ethical performance. This is due to the fact that when engineering students are introduced to and become acquainted with the robot ethics, they will definitely recognize any breach of ethics. Following this, the designed and applied course should be assessed to find out that it has a positive impact on students' ethical awareness and behavior.

Based on the information they receive about robot ethics in the second stage, the majority of the participants highlighted the significance of developing the ethical side in robot's applications. They also revealed that no matter what the efforts were to develop robots' autonomy, robots should be ethically programmed and deployed. They suggested that robot could be ethically programmed in cases where they can respect human values such as "sympathy, love, honest". The vast majority of the participants affirmed the importance of integrating privacy and security so as to make robot ethical "ethics can be integrated in robots by measuring the proficiency and security of the actions robot make", "I think robot can be made of ethical functionality by making them more secure, thus saving privacy should be 100% guaranteed", "the most important thing is to ensure safety, security and privacy". They asserted the point that people's right to privacy concerning their rights protections of their emotional needs as well as physical and psychological frailty should always be respected to the greatest extent according to sensible design objectives. This is due to their concerns about access to and storage of information by various users and programmers. They think that robots should provide enough privacy for their users, thus programmers should use accurate algorithm that pose restrictions on the extent to which they should unveil or reveal personal data. They emphasised the point that trustworthy system design principles should be used in all stages of robot's operation including hardware and software design to guarantee secure data processing on or off the platform. They suggested having a priori analysis of every state the robot may encounter in this respect and implementing a way to evade any potential unethical behaviors of breaching people's privacy following safe implementation of formally defined ethical principles and rules. This result is in agreement with [14] claim that privacy is an essential ethical issue in robot ethics.

They also emphasised the point that robots programs should consider the ethical problem that occur as a result of using robot". Some others emphasized the

point that ethics should be based on a rule that is "robot should not be used to harm others; for example they should not be used in war or nuclear energy" as they may pose detrimental impact on humankind. They asserted the connection between robots ethics and the way users employ them "how to use them is more significant", "ethics can be integrated by putting this technology in the right hands to make/reap the possible benefits to overshoot the associated the unexpected risks", "Privacy is also a very important factor as such robots should never be used to spy on people", "they are ethically employed as long as they do what they are supposed to do and do not negatively affect human safety". Thus, they believe that if robot assigned a job, they should obey the users' instructions only and they should not be easily accessed or programmed by another user using certain security procedures and systems such as using codes and finger, eye or voice prints once needed.

In light of the finding that the vast majority of the participants associate robots with privacy problems, the issue human replacement by robots appeared to provoke more ethical concern. Despite all their suggestions, the vast majority of the participants agreed that though robots may be usefully deployed in domestic, industrial and administrative affairs where they have the potential for compensation and enhancement (being more accurate and faster than human), they should not replace people entirely in very critical situations such as dealing with vulnerable people (e.g. children, elderly, and patients) and taking control in very fatal situations (e.g. surgery for chronic situations, nuclear productions and war arena). They believe that in such situations, emergency cases and unexpected events robot should work either under human supervision or with human intervention. They justified that by mentioning some of the experiences of using robots in certain dangerous situation that resulted making decisions and behaving unethically that led to lethal errors and harming others. They ascribed this to the fact that robots do not have the emotional and intellectual sides of humans. For example, the participants state that "No. Robots should not be used with no human supervision when dealing with kids and patients, for instance, because sympathy is the key in such situation and robots lack it", "I do not accept using robot in certain situations such as dealing with autism kids as they are not intelligent enough take very sensitive decisions under very crucial unexpected conditions. Besides these reasons, some participants highlighted the social implication of robots' entire replacement of humans such as the long term effect on people's emotions and social skills, the cold mechanistic aspects of employing robot in health care as well as the unemployment as the very nature of humans is their love of work and living in a friendly atmosphere. Those revealed their fears that robot will remain a machine that cannot be entirely ethically depended on (I think robot can't keep secrets and

can't take accurate spontaneous actions like human because anyone can use or reprogram them and their programs might go wrong anytime. Therefore, they confirmed the responsibility designers and manufacturers hold in determining the level of safety considering the robots' level of autonomy and learning ability so as to ensure having safely designed hardware software and human-robot interactions. There was a slight allusion to the appearance of the robot, the extent of people's attachment to robots and humanizing robots and their impact on psychological change of the society as the main concerns that pose ethical issues. Thus, they should also be carefully considered during designing robots. Many participants revealed the significance of having an international consensus on what type of ethics robots should have. This is due to the fact though societies share certain ethics, they also have their own traditions and ethical rules. These results highlight the importance of conducting more world-wide research so as to reach an agreement on the sorts of ethics that should be implemented in robot if they are to be considered ethical.

### VIII. CONCLUSION AND RECOMMENDATIONS

The study investigated engineering students' awareness and conceptualizations of ethical issues as well as their suggestion on how to embody ethics in robots. The results revealed the lack of knowledge on the engineering students' side about ethics. The students' responses are not in agreement so as to show a concrete image of their conceptualization of robot ethics. Overall, the participants asserted that robots should be programmed using a special algorithm that consider the ethics that serve and respect human safety, privacy and security. In light of results, the researcher recommends that there should a specified full-scale robot ethics-based induction including teaching ethical issues, professional ethical codes of conduct. The course should also deal with certain practical cases and states to endow engineers certain ethical skills to deal with new ethical problems. The present study opens up new avenues for more future research to be conducted on exploring engineers' ethical awareness and assessing the impact of the designed and applied course on students' ethical awareness and behavior.

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