Impacts Robotics are having on the world

Glenn Nicholas Mooney Purtill

155340083

Review article for CS275 2016

B.Sc. Computer Science and Software Engineering

Department of Computer Science

National University of Ireland, Maynooth

Co. Kildare

Ireland

A review article was submitted in partial fulfillment of the requirements for the continuous assessment of the Directed Reading in CSSE module CS275 on the B.Sc. Computer Science and Software Engineering

Lecturer: Mr. Joseph Duffin

Table of Contents:

Abstract

There has been an exponential growth of robots over the past decade. Robots are incredibly clever machines and are only going to get smarter. With the constant progression in the research of Artificial Intelligence, aids robots to become more interactive with humans for example facial or voice recognition. In this modern era, we are surrounded by robots. We are lucky to be a part of this current generation because there has been incredible advances in the robotic sector and we are noticing them being implemented in our everyday life. People of the future probably wouldn't be able to recognise the growth of robotics in their society. This article will explore how robots are impacting the world in a positive sense and in a negative sense. This article aims to identify the pros and cons of robotics through certain subtopics which are; Robotics in Healthcare, Ethical challenges, robots in industry, Military Robotics and the future of robotics.

Introduction

In this day and age, it is not uncommon to come across a robot in your everyday doings. If we were to rewind back ten to fifteen years ago you would be very unlikely to come across any sort of robot. Robots come in all shapes and sizes. Due to the constant investigation into areas such as artificial intelligence and mechanical engineering, we are seeing how robotics are advancing at a startling rate.

Robotics research began in the 1940's. Uncertainty was one of the main themes for researchers as they conducted there research. (Mason, 2012). Robotics has come a long way since the research conducted in the 1940s, we have seen the production of many different robots since then. A recent robot that has been developed is HUBO 2 plus. With the help of artificial intelligence, the HUBO 2 plus is able to sense the environment that

it is in using nothing but a camera. Robots like HUBO 2 may become a big threat to the safety of humans around the world, this article will explore the uncertainties of this. (Smashing Robotics, 2012)

This article will review how Robotics in healthcare is benefitting society, Ethical challenges for robotics, the impacts of having Robotics in industry, robots in the military and the future of a robotic dense society. I used IEE Explore, Science Direct and the web to conduct my research. I used search terms such as: 'Robotics', 'Artificial Intelligence Robotics', 'History of Robotics', 'Medical care Robotics', 'Surgical Robotics', 'Robotics Morals', 'Robots in Military', 'Robots Future', 'Robotics in industry' and 'Robotics Ethics'.

Robotic History

Early conceptions of robots stretch back to 3000 B.C, Egyptian water clocks used human figurines to strike the bell every hour. In the first century A.D Pentronius Arbiter invented a lifelike doll that moved similar to a human and Giovanni Torriani invented a wooden robot that fetched the emperor's bread daily. In 1495 Leonardo Di Vinci drew sketches of the first humanoid robot (All On Robots, 2013). The 19th century seen the creation of the Edison doll and a steam powered robot made in Canada. In the 20th century, robotics exceed expectations of many people with the creation of many advanced robots. This is thanks to the advances in mechanical and electrical engineering. In 1950s, an inventor named George C. Devol invented a reprogrammable manipulator called 'Unimate'. There were many different robots that where around the time of the millennium, like I've mentioned above, The HUBO 2. In the 21st century the advances in robotics have again exceeded expectations. With the research into artificial intelligence allows robots to become more interactive. Looking back at what

robotics where to what they are now shows the incredible strides of progress that robotics has taken and there seems to be no end to the progression, making the future of robotics looking bright(Roberts, 1999)

Robotics in Healthcare

Robots are being used in Hospitals and in nursing homes around the world. Mostly, these robots are used in surgery's with the assistance of a surgeon, but there does exist robots that can carry out a full surgery by itself. In an article called 'Ethics of Healthcare Robots' the author questions the responsibility of theses robots. He raises questions such as; will health workers jobs be taken by robots? And can robots give the same level of care as a human can?(Stahl & Coeckelbergh, 2016). If robotics are to take jobs of health workers, this would result in higher unemployment rates, which is an example of a negative of robotics. 'Care Robotics' is a term used to identify a robot who do care activities for a disabled person. 'Paro' is a care robot which is used to aid patients which is suffering from dementia. Paro has two microphones and many sensors to detect stimuli. Paro interacts with its patient with its fins and eyes(Goeldner, Herstatt, & Tietze, 2015) The robots that depend on a surgeons actions are Controlled Systems, Automatic Systems are systems that have been programmed by a surgeon before and Semi-Automatic Systems are systems that depend on a surgeons movements. (Sharkey, 2013) Using robots in surgery declines the risk of human error and can improve the precision of the surgery. Although this sounds like good news, these systems are controlled by a computer system, with computer systems comes bugs and hackers. If there was to be a fault in the computer system it could be fatal for any patient, I will speak more about this below. A surgical system called 'Da Vinci' was installed into over 1900 hospitals worldwide. This system was designed by the 15th century Italian

artist Leonardo Di Vinci. Intuitive Surgical are the manufacturers that released the Da Vinci system. President Obama was pictured operating the system which lead to incredible publicity for the manufactures. Robot aided prostatectomies done in the US increased from approximately 5,000 in 2002 to 73,000 in 2009. These figures would only indicate positive impacts for patients due to its incredible increase in 7 years. The Da Vinci surgical system is being used to treat prostate and gynaecologic cancer and it's also used for invasive hysterectomies. Although there are many positive impacts of the Da Vinci system in hospitals, there are also some negatives. Juan Fernandez, a 49 year old Chicago native lost his life just two weeks after the Da Vinci robot was used to remove his spleen. It was the first time this doctor used the surgical system on a living person. The doctor was sued for medical malpractice and the family was given $7.5 million for their troubles. In another case, a 42 year old women was left with permanent damage after her ureters were severed, resulting in her kidneys to shut down. Again a law suit was opened for gross negligence, accusing that the surgeons didn't have the required training and experience to use the complicated system.(Sharkey & Sharkey, 2013) This is of course is seen as the negative side of robotics in healthcare. From the two above cases, the Da Vinci system was not to blame for the unfortunate outcomes, but the fault of the human controlling the machine. To use these highly skilled machines requires a lot of training. These machines can and have become very dangerous to the public if it isn't in the control of highly trained surgeons. The below image shows the Da Vinci system.

(Intuitive Surgical, 2016)

New technologies in the area of medical care promises modernisation and enhancements over previous methods, but over time we will see if these improvements are truly revolutionary. Roy Amara (past head of Institute for the Future) once stated "We tend overestimate the effect of a technology in the short run and underestimate the effect in the long run." This statement is accurate to the area of 'Robotics in healthcare' because we may not see the immediate benefits of these new technologies in healthcare, but experts believe it will have long term benefits for humanity, hence the heavy investment.(Sharkey & Sharkey, 2013)

Ethical Challenges

Robotic ethics is an ongoing debate for everyone in the robotic community and in some cases there is no right answer, or at least no one has come up with them yet. The word 'Roboethics' is being used to define applied ethics for robotics. Developers must be careful when developing devices so that the wont breach privacy laws. Breaching

privacy laws can include acessing microphones or cameras that may be on the device Robots can record any humans habits, tastes and profile, this information may be gathered and sold to other companies in order to try sell you something.(Veruggio, Solis, & Van Der Loos, n.d.). Ethical challenges exist in healthcare. Francis Moore (Surgeon) proposed three requirements for ensuring surgical innovation is satisfactory, these are; sufficient laboratory experience, sufficient intellectual and technical expertise and Institutional stability. As well as these three guidelines, facilities doing robotic surgery must have surgeons that have sufficient resources, experience and training.(Sharkey & Sharkey, 2013) Two philosophers, Jane Johnson and Wendy Rodgers introduced four ethical challenges for surgical innovation. These four challenges must be solved if it is to truly revolutionary. The first challenge is Compromised informed consent. Patients must give their consent once they are completely understanding of the risks. The next challenge is conflicts of interest. Surgeons may be attracted by the benefits and attention associated with being a surgical innovator. The creators of these new technologies may enjoy the sensation of being the leading age and ignore some of the health and safety risks. The next ethical challenge is harm to patients. There is a constant danger with using anaesthesia and with longer holiday stays as it increases the chance of infection. This can result in a loss of trust in medical personnel. The final ethical challenge is unfair allocation of healthcare resources. Healthcare professionals tend to hype the positive effects associated with new expensive treatments even though previous treatments maybe safer and cheaper.

Robots in Industry

With the evolution of modern day technology, recessions and economic developments also aided by the forever needs of humans, puts an incredible amount of

pressure on the world's economy and on the financial side of businesses (Dirican, 2015). Robots have been in industry for many years. Prestigious Car Company's such as Ford, are using robots instead of humans to assemble their cars. Robots are becoming very useful to health and safety as the replace humans in dangerous conditions. An example of such industry is the oil and gas industry, robots are used here to improve work efficiency and safety. These oil and gas plants used a vast usage of pipes storage tanks, used for exploration, extraction, transportation, processing and distribution of this raw materials. Regular inspections and repairs are necessary to ensure these pipes and storage tanks are kept in the best conditions possible. Humans were required to climb into the pipes and tanks to carry out the inspections and maintenance. The conditions inside these pipes and storage tanks are massively hazardous. Any sort of oil spill or undetected gas in these pipes have resulted in fatalities. Robotics are extremely useful in these situations, in-pipe and tank inspection robots have been developed which removes any chance of a fatality when these inspections are being carried out. Removing humans from hazardous situations such as this is of course being seen as a positive impact of robots in society. This can also be seen as a huge positive for oil and gas companies, of course the main goal for these companies is to make profit and resorting to a robot to go through the pipes detecting flaws is a lot cheaper than the traditional ways of getting to these below ground pipes and detecting flaws. (Shukla & Karki, 2016) Robotics in industry have no doubt have their positives but also has its negatives. Robots have been used to replace humans in hazardous conditions, but they are also used to replace humans for financial purposes. For example it is to a lot cheaper to pay for a robot to carry out hours of manual work then pay a human. Robots are replacing lower skilled workers on a large scale and on a lower scale, middle skilled workers.(Graetz & Michaels, 2014) The rise of unemployment rates would be an

example of a negative impact that robots have on society.

Robots on the Front Line

War ultimately ends in fatalities, in-order to yield the exposure of personnel, animals were trained to endure certain task that where dangerous for humans to be in. As technology developed, research into military robotics began and new robots where developed that proved very beneficial to the militaries. Robots are being used to by the military for attacking or scanning for the opposition. There has been an exponential growth of drones in the military, theses drones have been invented to fly over a certain area and drop bombs on a certain district. According to an article called 'U.S Military Robotics Initiatives', the author states that the Engineering department in Pennsylvania University received $5 million from the Department of Defence (DF) to create 'swarm' robots. These robots where a part of an initiative by the DF to scan building for bombs("U.S. Military Robotics Initiatives," 2005). Military robots are also being used for combat and rescue operations as well as surveillance operations. Ongoing research is trying to achieve robots to do its job autonomously and for it to be as efficient or even more efficient as a human(Khurshid & Hong Bing-rong, 2004). Ultimately the research goals were to reduce casualties. Similar to industry, Robots are being used to remove humans in harsh and possibly fatal conditions. Removing humans of the battlefield is a huge positive impact of robotics. (Khurshid & Hong Bing-rong, n.d.)As these military robots are still being developed is there a chance that they will be a threat to society away from the battle field? Recent history has shown that many weapons have been smuggled onto our streets through the military. The price of guns would have dropped considerably over the last 50 years. Although these robots are incredibly expensive in this day and age, there is no reason to suspect that prices won't fall like they have done

for guns. Questions have been raised asking if these ‘Killer Robots’ should be stopped before they reach our streets? An article published by CNN claims that killer robots are near and they will be hard to regulate. (Toby Walsh, 2015) I will speak more about this in the section below.

What does the future hold?

Due to the exponential growth of robotics in our society it is only right to address the probable repercussions. According to an article called ‘Anticipating Our Future Robotics Society’, in Holland, an online survey was carried about impacts that robots are having on society. Majority of the users that took this survey associated a robotic future as having positive impacts of proficiency. Positive aspects mentioned in the survey contained points such as decrease of casualties and convenience. Negative points that where included where the loss of jobs and robots lack of social skills. From the same survey, humans where asked to type words in which they associate with robots, this is shown in Fig 1 below.

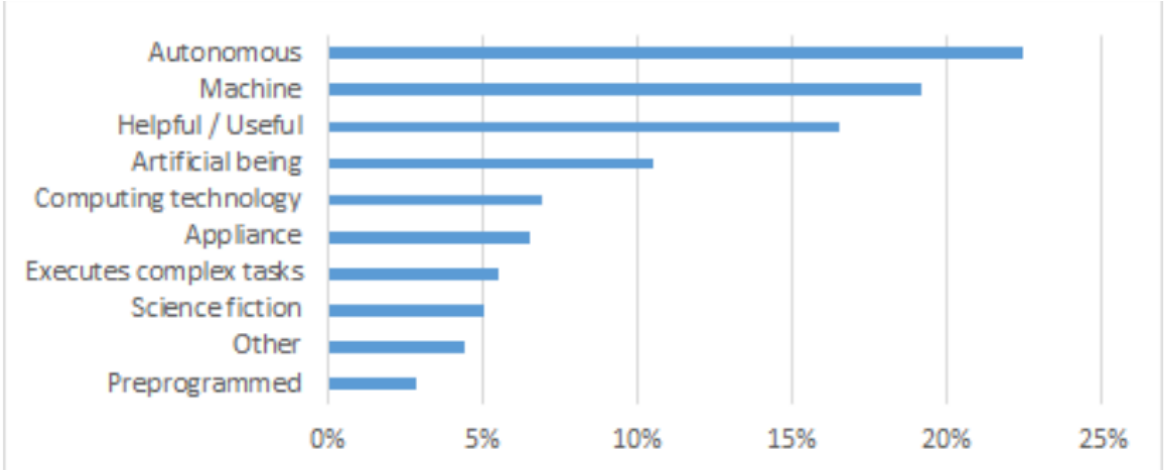

Fig 1 shows words associated with robots. (de Graaf & Ben Allouch, 2016)

As you can see from fig 1, helpful/useful are words in which are highly associated with robotics. This is evidence of positive impacts that robotics can have on society.

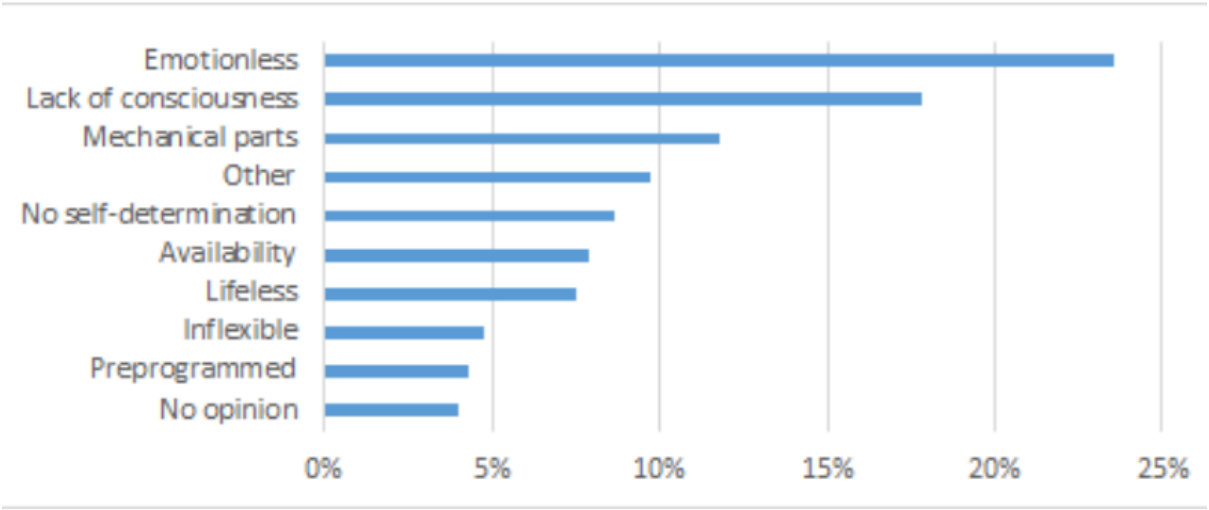

Fig 2 shows words that differentiate humans to robots. (de Graaf & Ben Allouch, 2016)

Emotionless is the most popular word that users used to differentiate humans to robots. This is evidence of negative consequences of having robotics in our society. (de Graaf & Ben Allouch, 2016) Overall humans have deemed robots in society as a positive, I believe these people are naïve of the potential threat of robots in our society. As I have mentioned in the above section, CNN have published an article about killer robots and they believe the future looks grime. This article claims that killer robots being in the hands of the general public is technically possible today. The article goes on to say that the price of these killer robots will be cheap and over time will only get cheaper, it also claims that lots of fatalities saying that surely these killer robots will get into the wrong hands, people who plan to cause harm. Although the some aspects of the future of robotic technology is exciting, it also has a dark side that will need to be kept under control by laws. (Toby Walsh, 2015) Robotics will advance to something we have never seen before. As you've seen from the history section, robotics has come a long way and

it doesn't seem like it's going to hit a plateau anytime soon. The exciting aspects of robotic future would be smart phones, using facial/voice recognition to open your car door or pay a bill. For robotics to reach its full potential, I believe new laws will need to be enforced to regulate robots, without laws a potential killer robot could fall into the wrong hands and could cause devastating. The direction in which robotics is going seems to be revolutionary for this world.

Conclusion

To conclude, robotics have revolutionised the way some people live their lives. Looking through some of the points I've made in my article, there seems to be a lot more positive impacts rather than negatives. For example, the Da Vinci system has been used in thousands of successful surgical operations around the world and the only unsuccessful operations was when the human controlling was at fault. Once sufficient training and experience is put in place these uncertainties will be ironed out. Overcoming ethical challenges is a big hurdle for any developer, having philosophers like Wendy Rodgers questions the ethics of surgical systems is only healthy as it helps developers endure the ethical challenges that they oppose. It's hard to decide whether robots in industry is mainly a positive impact or a negative impact. On one hand you have people being removed from hazardous situations such as the one I mention in the oil and gas industry and on the other hand you have the people losing their jobs to robots. For business, robotics are very welcomed as they allow companies to improve their profits. Robots remove humans in traitorous conditions in the military, they also give the military an advantage in terms of surveillance. The threat of robots becoming available on our streets are high so regulations would have to put in place now to try yield the supply. To this day, robotics has had a revolutionary effect on the world for

the better, but laws if more laws are not introduced in the near future there will be negative consequences.

Declaration

I hereby certify that this material, which I now submit for assessment on the program of study as part of the continuous assessment for module CS275, is *entirely* my own work and has not been taken from the work of others - save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: Glenn Purtill Date: 18/12/2016

References:

All On Robots. (2013). Leonardo da Vinci's robots. Retrieved November 17, 2016, from http://www.allonrobots.com/leonardo-da-vinci.html

de Graaf, M. M. A., & Ben Allouch, S. (2016). Anticipating our future robot society: The evaluation of future robot applications from a user's perspective. In *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)* (pp. 755–762). IEEE. https://doi.org/10.1109/ROMAN.2016.7745204

Dirican, C. (2015). The Impacts of Robotics, Artificial Intelligence On Business and Economics. *Procedia - Social and Behavioral Sciences*, *195*, 564–573. https://doi.org/10.1016/j.sbspro.2015.06.134

Goeldner, M., Herstatt, C., & Tietze, F. (2015). The emergence of care robotics — A patent and publication analysis. *Technological Forecasting and Social Change*, *92*, 115–131. https://doi.org/10.1016/j.techfore.2014.09.005

Graetz, G., & Michaels, G. (2014). Estimating the impact of robots on productivity and employment | Robohub. Retrieved December 15, 2016, from http://robohub.org/estimating-the-impact-of-robots-on-productivity-and-employment/

Intuitive Surgical. (2016). Intuitive Surgical - da Vinci Surgical System Si. Retrieved

December 18, 2016, from http://intuitivesurgical.com/products/davinci_surgical_system/da-vinci-single-site/

Khurshid, J., & Hong Bing-rong. (n.d.). Military robots - a glimpse from today and tomorrow. In *ICARCV 2004 8th Control, Automation, Robotics and Vision Conference, 2004.* (Vol. 1, pp. 771–777). IEEE. https://doi.org/10.1109/ICARCV.2004.1468925

Mason, M. (2012). Creation Myths: The Beginnings of Robotics Research. *IEEE Robotics & Automation Magazine*, *19*(2), 72–77. https://doi.org/10.1109/MRA.2012.2191437

Roberts, E. (1999). Robotics: A Brief History. Retrieved December 15, 2016, from https://cs.stanford.edu/people/eroberts/courses/soco/projects/1998-99/robotics/history.html

Sharkey, N., & Sharkey, A. (2013). Robotic surgery: On the cutting edge of ethics. *Computer*. https://doi.org/10.1109/MC.2012.424

Shukla, A., & Karki, H. (2016). Application of robotics in onshore oil and gas industry—A review Part I. *Robotics and Autonomous Systems*, *75*, 490–507. https://doi.org/10.1016/j.robot.2015.09.012

Smashing Robotics. (n.d.). Thirteen Advanced Humanoid Robots for Sale Today - Smashing Robotics. Retrieved July 27, 2012, from https://www.smashingrobotics.com/thirteen-advanced-humanoid-robots-for-sale-today/

Stahl, B. C., & Coeckelbergh, M. (2016). Ethics of healthcare robotics: Towards responsible research and innovation. *Robotics and Autonomous Systems*. https://doi.org/10.1016/j.robot.2016.08.018

Toby Walsh. (n.d.). Rise of killer robots -- and why we need to stop them - CNN.com. Retrieved December 15, 2016, from http://edition.cnn.com/2015/10/26/opinions/killer-robots-walsh/

U.S. Military Robotics Initiatives. (2005). *IEEE Robotics & Automation Magazine*, *12*(3), 108–109. https://doi.org/10.1109/MRA.2005.1511876

Veruggio, G., Solis, J., & Van Der Loos, M. (n.d.). Roboethics: Ethics Applied to Robotics. https://doi.org/10.1109/MRA.2010.940149

Word Count: (not including references) 3128

(everything) 3692.

Acknowledgements

I would like to thank Joseph Duffin for his help throughout this project and for helping me to prepare to write this article. I would also like to thank my classmate Michael Saly for his help and constant support.