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The Future of Robotics: An Advanced Ethical View of Robotics Contributing to Elderly Care, Medicine, and Workforce Participation

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1

Introduction

The definition of artificial intelligence (AI) was first introduced in 1956 at the Dartmouth Conference in Hanover, New Hampshire [1]. According to its two founders, Marvin Minsky and John McCarthy, AI can be defined as a wide set of methods and techniques developed to enable computers to solve problems and achieve various kinds of goals [2].

A robot is a paradigm of AI in an existing body. It is a physical machine equipped with sensors, actuators, and interfaces controlled by a software which enables the machine to acquire data, represent knowledge, extract information, and move in real world in real time [2]. Ordinary people as well as mathematicians, scientists, and philosophers first became familiar with robots through the movie "Wizard of Oz" and science fiction movie "Metropolis" [1]. Since then, more and more people have begun to suggest that not only human beings, but machines also can use information in order to solve problems and perform necessary actions.

The very first robot ever to be used was in 1958 by General Motors and this served as the prototype for robots later [3]. Once the general public saw how efficient that robot was on the assembly line, the robotics industry exploded. Following the Unimate robot in the car industry, Neuromate was brought about in 1991 that was used in the medical field [3]. Now with more research, there have been improvements in technology and robots and robotic applications are now classified into three categories – robots that can assist and serve humans in their daily lives (e.g., elderly assistance, surgery, and military applications), robots that are used to rehabilitate and augment human abilities (robotic wheelchairs and exoskeletons), and lastly, robots which replace physical labor and jobs in hazardous environments (construction workers and welding jobs) [2]. Robots are designed to decide the best course of action, communicate with other users or other machines, and learn to improve themselves based on their experiences just like what human beings do. Their capacities vary based on application. In this paper we will focus on robotics' usage in all three contexts – assistance with the process of aging, performance in complex surgery, and assistance in the workforce. We shall address these three themes in three separate sections.

Our Two Ethical Lenses: Care Ethics and Virtue Theory

One of our goals in this paper is to explore the role of robotics in successful aging by using Virtue ethics and Care ethics.

Virtue ethics seeks to promote a good character by emphasizing a "virtue in moral philosophy" [4]. Many contemporary virtue ethics theories are based on Aristotle's thought about a virtuous person who possesses various ideal character traits. Those character traits are acquired from birth assisted by training and habits which must be practiced repeatedly before they can get ingrained. Aristotelian virtue is generally understood as the mean between two extremes of excess and deficiency. Finding a middle position or the Golden Mean in between two extremes would produce moral or virtuous behavior [4].The development of virtues plays a crucial role in dealing

2

with different emotions which are the driving forces behind our actions. Virtues include character traits such as courage, which provides us strength in the moment of challenges, temperance, which provides self-control preventing anger or overdoing on the pleasures of life, kindness, which makes us care about other people and their needs, etc. Unlike deontology and consequentialism, virtue ethics do not emphasize duties/obligations nor actions that will bring certain consequences. Indeed, it gives a more general advice: "Act as a virtuous person would in your situation" without a specific guidance for action [4]. A virtuous person can be defined as someone who is generous throughout different circumstances over a lifetime because of his or her character and not because what he or she seeks for personal benefit [4].

The ethics of care maybe called as a modern branch of virtue ethics. It is often defined as a practice rather than a theory. The ethics of care focuses on the moral importance of relationships and human interdependencies throughout one's life. According to the ethics of care, the network of caregivers and care receivers is an important factor in a prosperous society [4]. This network of caregiving relationships cannot be abandoned at will. Motivation to take care of people who are vulnerable or dependent often arises from virtues such as gratitude and compassion. The process of taking care or nurturing someone brings memories of how one was nurtured or cared for. It inspires us to consider needs not only of ourselves but of other people.

These two lenses, virtue theory and Care ethics, will now assist us in getting an insight into how to embrace the robotic technology in the field of elderly care by introducing the idea of optimal aging.

The Medical Model of Successful Aging

The society we live in shapes our minds and influences our decisions. It internalizes rules, goals, and expectations that people should follow. Aging is a natural and inevitable phenomenon which all of us have to go through. However, one can establish some models for happy and independent aging by introducing the idea of optimal outcomes. Such a paradigm for successful aging in gerontology was introduced by John W. Rowe, MD and Robert L. Kahn, PhD in 1998 in order to address the growing population of aging people and to identify mechanisms leading to successful aging [5]. According to its founders, low risk of disease and disease-related disability, high cognitive and physical functional capacity, and active engagement in life are the key components leading to independent and successful aging and ultimately to a good and fulfilling life [5]. However, the concept of successful aging is not about meeting the requirements listed above. It is more about the relationship among those requirements by combining the absence of disease and maintenance of functional capabilities with active engagement in life which in turn also includes interpersonal relations and productive activity. Later, this successful aging paradigm was revised by adding an extra factor of positive spirituality which provided a cognitive framework leading to reduced stress, social isolation, and increased well-being. This we can see in the figure below [Fig. 1].

3
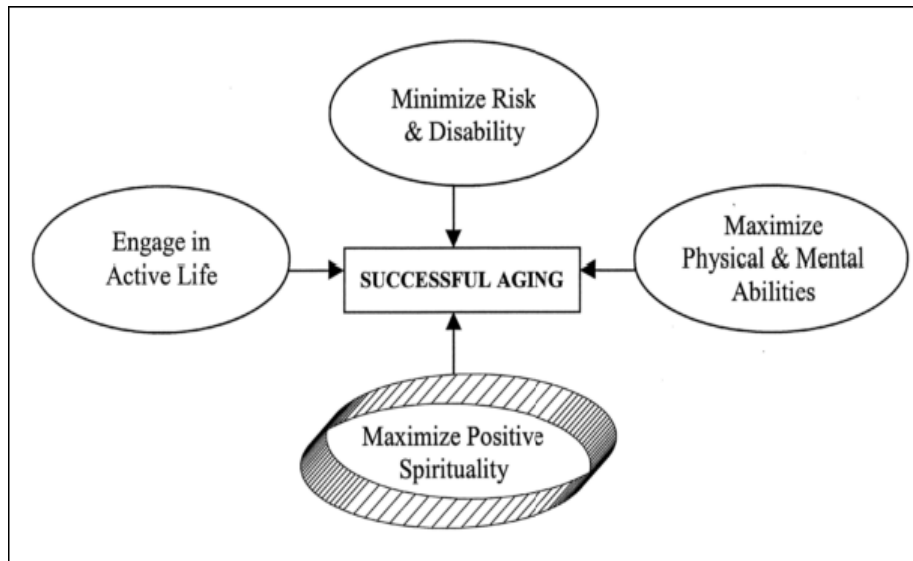
Fig. 1. Revised Rowe and Kahn Model of Successful Aging [6].

According to Rowe's and Kahn's model of successful aging, being productive is a societal value [5]. Unlike young adults, elderly people might prioritize different societal values such as safety, respect, trust, tradition, and altruism just because of the aging process, life's experiences, and changes in their social environment [7]. It is very important to encourage independence and dignity while providing the senior care. This conformity to social value plays an important role in elders' well-being and good life phenomenon. Unfortunately, not many successful and healthy aging research paradigms have addressed social values which play a crucial role in laying a foundation for a good society which provides healthy interpersonal relationships and a good prosperous life. This "good life" phenomenon is quite vividly explained by Aristotle in his virtue ethics. According to Aristotle, the good life is a "flourishing" life and happiness or *Eudaimonia* – living well and faring well – is the ultimate purpose for which human beings exist [8]. Aristotle proclaims that "happiness is the activity of the soul in accordance with virtue" and this can be achieved over a lifetime through virtuous behavior which is essential for making moral decisions [9]. Unlike deontology and utilitarianism, virtue-based ethics does not emphasize rules or actions that people should follow but speak of the different character traits which would help people to develop correct motives necessary for decision-making once faced with difficult choices.

The notion of virtue raises a question of how we can ethically implement robotic systems into elderly care by helping elders in accomplishing healthy and happy lives?

Referring to Virtue Ethics and Aristotle's statement that only humans possess reason necessary for the virtuous action, it suggests that only humans and not robots would be capable of moral action. Robots, unlike humans, cannot make conscious decisions and act on those decisions, thus they cannot feel happiness or achieve *Eudaimonia*. So, it is upon us, the humans, and our moral character that can design how ethically to apply robotics in elderly care.

4

The Role of Robotics in Successful Aging

The shortage of caregivers together with a rapidly aging population is a major issue in the U.S and in many other developed parts of the world. According to the US statistics, in 2050 the population aged 65 and older is estimated to be 83.7 million which would be almost double from 2012 [10]. Regarding the number of caregivers, currently there are about 7 people for each person who is 80 years old or older [11]. However, it is expected that this number will decrease leading to 4 or even lower number of caregivers by 2050 [11]. Average cost of a private room in a nursing home is approximately $92,378 and it is expected to increase [11]. On top of this, the majority of elders experience a number of chronic diseases and prefer "aging in a place" by staying at home [12]. Considering issues of a rapidly growing senior population, lack of professional caregivers, expensive elderly care etc., modern societies need robotic technology which could make up for the shortage of caregivers and support people in their process of successful aging from a stable place.

Robotic care offers enormous benefits in elderly care because of the robots' high capacity to work round the clock and to perform similar and repetitive tasks as professional caregivers. Robots can assist the elderly with their day-to-day needs by reducing daily chores and allowing them more time for socialization and other cognitive engagements. The elderly people can then maintain more independence with robots playing the role of human caregivers. At first, it might be unusual to entrust elderly care into technological hands because care provided by robots and human beings might feel different. The most important differences would include physical human touch and human consciousness which influences thoughts and behavior. Unfortunately, a conscious robot with a physical human touch has not been developed yet. But does the elderly always require physical human touch or something with human-like consciousness? Maybe. But majority of the elders need assistance in their daily living activities and some emotional support in order to enjoy independent and successful aging.

There already are some form of robotic caregivers which can assist seniors in their everyday tasks for e.g., Bestic robotic arm, which provides independent eating for those who have difficulties of using their arms, Giraff robot, which allows healthcare staff virtually interact with a senior who is living at home, Hector, which help keep a daily routine of the seniors and detects emergencies, and many others [13]. These robots provide not only the necessary assistance for the elderly but also release actual human caregivers from their duties so that they can perform other tasks. Also, some are even capable of providing physical therapy by making therapy more interactive and efficient, ultimately contributing to the increase of independence and dignity of the senior individuals. Dignity and respect are fundamental to human rights which should be a part of an ethical healthcare practice.

According to Aristotle, a virtuous friendship, which is a relationship without ulterior motives, is the most enjoyable kind of companionship which can contribute to an individual's inner emotional fulfillment and happiness [9]. There has been some development of social robots which can arouse feelings of love, affection, and joy in people's hearts. Life without these feelings would become meaningless because people need emotional fulfillment and attachment. Lack of it would

5

impede successful aging; therefore, such robots could help them to achieve some level of emotional fulfillment. Paro, the seal robot, is one of the most famous interactive robots which serves as a "therapy animal" by providing a pet-like social companionship. It was approved for neurological therapy in the U.S. because it reduces stress and anxiety, improves motivation and relaxation, and provides an experience of socialization [14]. The robot is unique not only because of its appealing appearance but also due to its remarkable capabilities, for e.g., it imitates the voice of baby harp seal, recognizes light and dark, the direction of voice and words, and actively responds to people's interaction by remembering their actions, etc. [14].

In fact, the demand for social robots is increasing among the elderly people. Thanks to our evolutionary history, human beings are basically herd animals. We need other people in order to maximize our happiness and also to minimize the feeling of loneliness. To show the detrimental effect of loneliness, let us look at Japan which has the oldest population in the world and over 25% of citizens are 65 years old or older [15]. According to statistics, one out of five prisoners there is a senior citizen [15]. More and more elderly Japanese people would willingly commit a crime in order to go to jail. Since the majority of them do not have families or seldom talk to anybody, jail becomes an alternative to avoid loneliness as it allows them to become a part of the community they were looking for. Another example is the United Kingdom where the Prime Minister, Theresa May, appointed a Minister for Loneliness. The British government and charities were encouraged to develop effective strategies to address the increasing issue of loneliness because, according to Yeginsu's article, it is much worse for health than smoking 15 cigarettes per day [16]. Loneliness and social isolation also contribute to increased risk of cardiovascular disease, anxiety, depression, dementia, etc. [16].

Japan and the United Kingdom have acknowledged the issue of loneliness by actively supporting the development and implementation of social robots. Paro and robotic dogs are only a few examples of companion robots which were successfully adopted by these countries respectively, by single children and elderly people. So, it is expected an increase in usage of social robots by other countries experiencing loneliness and rapidly aging populations due to their therapeutic and companionship effects.

Robotics thus can be developed as a proxy in elderly care and assistance. Referring to Aristotle's idea of a golden mean, a virtuous person should not develop robotics just for the sake of capturing the market running for that would be a kind of excess and perhaps even of the waste of resources. A virtuous person also should also not be very minimalistic about the development and usage of robotic technology for that might lead to deficiency. Overall, a virtuous person's optimal preference for robotics implementation in elderly care should be based on efficiency by targeting particular elderly care problems. Specifically, the development of robotic technologies would target four categories of daily living activities which most elderly people struggle with – they are basic activities such as bathing and dressing, instrumental activities such as management of medication regimen, enhanced activities such as buying groceries, or social activities such as communication and interaction with others. So, the implementation of robotics into the elder's

6

care would not only substitute the shortage of caregivers but would also provide a modern optimal way of aging by fulfilling individual senior's needs.

Is it a good thing to use robotics for elderly care?

Aristotelian virtue ethics promotes a set of character traits leading to well-being and flourishing lives whereas care ethics emphasizes the mutual relationships between caregivers and care receivers (e.g., parent-child relationships) that span human life. While Aristotelian virtue ethics identifies a human still as an independent autonomous individual, care ethics emphasizes human's dependence on others [4]. Children immediately after they are born are dependent on their caregivers because they cannot take care of themselves. After some time, the caregivers get older and ultimately reach a point when they need caregivers for themselves. Both aging and reliance on others are inevitable and predetermined. No matter how hard people try not to age, eventually they will get old. No matter how hard people try to be independent, eventually they will face situations when they have to rely on others.

So, is introducing robotics in elderly care a good thing? We shall try to argue that in some sense it can be. In today's world, not all seniors have children, relatives, or friends who can provide them with long-term necessary care. Even if they have children, not all of them can provide necessary assistance with their parents' basic daily living needs such as dressing, bathing, managing a medication regimen etc. There are many reasons why children are not able to take an active role in their aging parents' care. Demanding job schedules, distance from their parents, children's own health conditions are only a few reasons complicating elderly care. But as parents had their moral responsibility to take care of the children, children also have the same moral responsibility to take care of their aging parents. Taking in consideration the care ethics and its emphasis on interdependent relationships between parents and their children, even if children cannot take care of their parents, they still remain morally obligated to them. Robotic technology could come in play as a tool for such children to express their benevolence, compassion, and responsiveness to their aging parents' needs.

But then, all of this raises a question: is this a natural or ethical caring? If children are engaged in natural caring for their parents, is it supposed to mean that they intrinsically or naturally want to do that? In contrast, if children take care of their parents because they are obliged to do that, are they still engaged in ethical caring? Based on these differences we can assume that if children do not have good feelings and do not feel that they are willing to take care of their old parents, then there may not be any value or a duty or an obligation. But does this always hold true? Sometimes when we start doing things naturally or not naturally, our minds follow our behavior. An example might be parents taking care of their small children. Do parents always naturally want to wake up in the middle of the night in response to their children's needs? No, they do not, but they must. So, feelings do not always come first, and behavior comes later, but in fact the behavior comes first and then feelings come later. This does also follow from Aristotle's Virtue Ethics. Virtues are developed out of practice and once they get ingrained in our character, such virtues

7

manifest themselves in our behavior. So, if the adult children begin to change their behavior, eventually their minds will naturally experience motives to take care of their elderly parents. And if the children have genuine situations in their lives which do not allow them sufficient time to take care of their elderly parents, they can still express their compassion and benevolence by getting their parents a social robot.

After covering the two different ethical perspectives on how robotics can be implemented in the practice of elderly care and successful aging, let us now look at their applications in medicine and how robotic technology can establish new standards in health care.

Part II
Robotics in the Medical Field

Since the first robots came about in 1954 in the car production line, there have been many improvements and changes made in the past 65 years. When the world saw the improvements that these robots brought to the society, they thought that these robots could do more than put parts of cars together. The idea of using robots exploded, and companies such as Intuitive Surgical and Hansen Medical devoted their time to develop the best surgical robot out there. The first robot that was used in surgery was for a brain biopsy in 1985 [18]. This procedure was very successful, and this robot served as the prototype for the Neuromate that was produced in 1991. Today, the technology has evolved so much that robots are not just in the operating room but also used for patient-doctor consultations. Due to the advance in technology, these robotic devices have been introduced into the medical field to increase surgery efficiency.

From then on, the production of many different prototypes of medical robots started to appear in the market. They are of three categories mainly – active, semi-active, and passive devices. The active devices are totally programmable and can carry out specific tasks on their own. The semi-active and passive devices translate movements from an operator's hand or other body parts. All three of these devices can carry out the functions that a surgeon would without being right next to the patient. Thanks to artificial intelligence (AI), this has greatly increased the efficiency and made things easier for us as humans. Of course, when there are benefits to something this intelligent, there are also many negative possibilities. A few that concern people include the cost of these devices, a non-human hand operating on patients, and the fact that if the robot makes a mistake, it will not know how to fix it like a human surgeon would. But the positive possibilities outstrip the negative. Besides efficiency, the benefits also include reduced cost and less healing time, robotic surgery being a less invasive procedure. The surgeon can just sit behind a wall and control the robot with a panel of controls. It is important that the scientific field is always advancing to stay caught up with the human body and the rapidly increasing mutations and disease that can take over anyone at any minute of any day [23]. Not everyone is on the same page when

8

it comes to using robots in the operating room but when they look at the bigger picture, and how amazing they truly are, their minds can be easily changed.
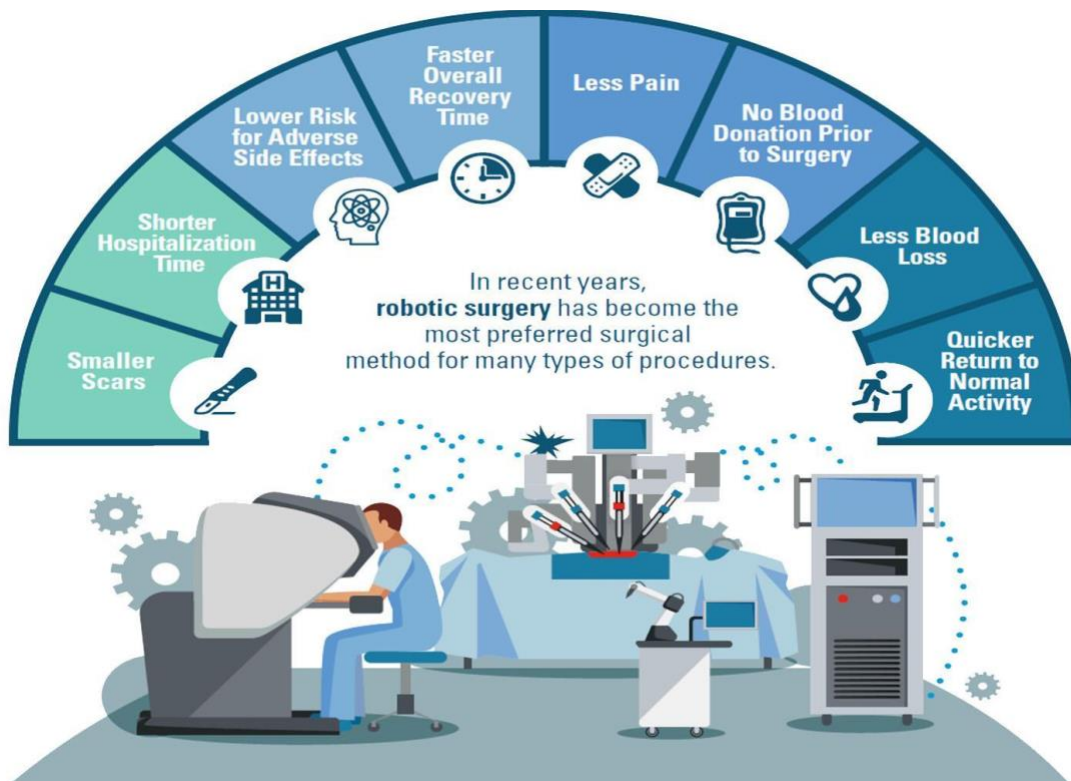

Figure 2: Benefits to using robotic devices in operations [9].

For the past 20 or so years robotic devices have been introduced into surgical procedures and the field is advancing quickly. Surgery is already an unpleasant process to begin with and most people would try to avoid it at all costs. An example of one of the most used medical robotic devices is the da Vinci Surgical System. It allows the surgeon's hand movements to be translated into smaller and precise movements of tiny instruments held by a robotic arm, inside the patient's body [1]. Apart from an accurate incision, its other key features include enabling surgeons to perform operations through very small incisions. This reduces the blood loss and ultimately speeds up the healing time, so who would not want to have an easier procedure and be up and back to their daily life in half the time? Also, the smaller tools would even allow to perform a surgery in a part of a body where a human hand cannot reach. Several key features include magnified vision systems that give the surgeons a 3D look inside the patient's body, wristed instruments that can bend and rotate more than a human hand can and many more.

A good example here would be when someone comes in with a major trauma and has a lot of internal bleeding. The human hands are not small compared to the abdomen so when multiple bleeders need to be stopped not all can be stopped at the same time which could be fatal. When a surgeon is operating with one of these new devices, they have the ability to very quickly stop all

9

bleeders by using the small instruments. Once the bleeding is stopped then the surgeons can come in and one at a time fix each part of the body that needs fixed. With the use of this robot, it allows almost all surgeries to take place using small instruments. While precision is one important and useful aspect, the ease of its use also allows the medical procedures to be done quicker and because of which more surgeries can be done in a day. Using these robots will increase the efficiency of the entire hospital. When surgeries increase, this will bring in more money to the hospital so more robotic instruments can be purchased. On the average, it was reported that there were 48 million surgical procedures carried out in 2009 in the United States [2]. If such a big number of people undergo surgical procedures each year, it is important that the surgical processes are done in the most effective and least invasive way possible.
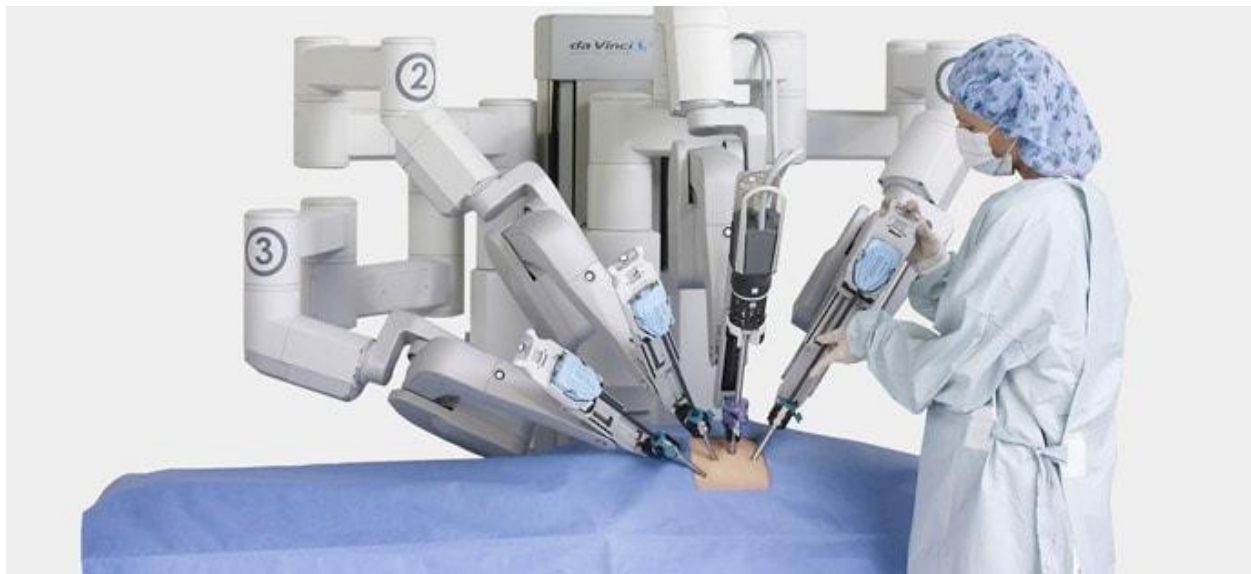
Figure 3: Most common medical robot used is the da Vinci [8].

The Two Ethical Lenses: Utilitarianism and Deontology

The two theories that we can use to evaluate robotic surgery are utilitarian theory and deontology. Utilitarianism is an ethical theory that separates the right actions from the wrong ones by arguing that a morally right action is that which maximizes utility by producing the greatest happiness for the greatest number of people [4]. On the other hand, deontological ethics is based on the idea that the morality of an action is based upon under a series of rules rather than the consequences of that action [3]. "Deontological ethics or duty-based ethics teaches that some acts are right or wrong because of the sorts of things they are, and people have a duty to act accordingly, regardless of the good or bad consequences that may be produced" [5]. These two ethical theories go hand in hand when it comes to robotic devices in the medical field.

Deontological theory lays down a number of boundaries that the robots cannot violate, so it is well applicable in the field of medical ethics. Indeed, the two theories serve something like the political process of checks and balances. When these robotic devices are used in medical

10

procedures, they must follow a written program. Since these devices are following these commands, there is no way that the device can do something outside these programs and its deontological boundaries. Robots performing the actions required for surgery will thus be right actions to treat the patients in the most ethical way. Sometimes surgeons might perform a technique that is not necessary and maybe not very ethical, so these written programs do not allow for such unnecessary modifications to take place. Sometimes it is necessary to use a different technique in order to save a patient's life, so this is when the surgeon can jump in and perform that technique needed. This ties back to utilitarian ethics because when such actions will produce the most amount of happiness for the majority of the people – patients and surgeons included. Furthermore, the algorithms that are written to direct the robots are consistent with the deontological principles. So, this checks and balance idea fits well with the greatest happiness of the greatest number principle.

Evaluating Both Sides

There are a lot of people that argue that robots are not human, and robotic devices will move very differently than the human hand. When these devices are operating, people are concerned that something might go wrong when these devices are working on them. After all, robots are metal machines and there is a chance that these devices can short out or stop working due to a glitch in the written program. While this is not something that happens very often, nobody would want to be under such circumstances.

Some people are also concerned if it is ethically right to use machines on humans. The way robotic arms and hands move will be very different then the way the human hand works, and there is a genuine concern that since they follow a written code, the robotic device can make a mistake and may not know how to fix it.

There are a lot of benefits and objections when it comes to using robots in the medical field but when one really looks at the benefits of these devices, they do better than harm. Some of these gains are the improved healing time, being less invasive and many more. On the other hand, people do not agree with a machine operating on them and do not think that is ethical. Robotic devices have the ability to perform surgeries in a more efficient way and are less invasive as well. Even though the doctor is not the one that is performing the surgery, it is still being carried under a doctor's control.

When robotic devices are used in the medical field this will maximize the well-being of the society in many aspects. When an actual surgeon performs a surgery, they might have to create a larger incision in order for them to access that particular part of the body. When a larger incision is made, this means a longer healing time for that patient. They might have to stay in the hospital for longer and not be able to get back to their daily activities. Instead of a surgeon doing a procedure like this, a robotic device can be used to increase healing time. The larger the incision, the more trauma the patient will be in for a longer amount of time. Since the robotic devices can

11

move 360 degrees unlike the human hand as well as being able to use very small instruments to perform the procedure. When there is a device that can do these things, this will decrease the size of the initial incision that needs to be made because the small tools can work in very small areas as compared to the human hand. Due to a smaller incision, the patients will not have to stay in the hospital as long or even at all, and they can get back to their daily activities sooner. That means the patients can go back their jobs sooner and lose less money and provide better for their families. This makes a big difference for everyone because no one wants to be laying around at home in pain. Typically, when you get admitted to the hospital for a procedure, the doctor will come and talk to you and explain everything. Hearing directly from the doctor about the procedure they are about to undergo gives them a sense of confidence. Interacting with the person that is responsible for your life is important to patients which will make them feel more comfortable about the procedure.

Another great benefit that might result from the new technique is accessibility, e.g., to locate tumors in cancer patients. There are many producers that might not be able to be performed in conventional surgery due to the location of a tumor or something of that sort. Instead of the doctor telling the patient that they cannot operate on them due to the location, they cannot use these robotic devices that can navigate themselves very precisely around arteries and nerves without causing any damage. These patients won't just have to go home and wait to die.

As seen from above there are a lot of important and beneficial aspects when robotic devices are used in the medical field, but whenever there are benefits to something there are always disadvantages and concerns with new technology.

One possible negative consequence is that it might irrevocably change the traditional doctor-patient relationship, which is based on trust and ongoing care. If a robot starts performing procedures instead of a human being, then this relationship might never exist. If the doctor is not the one that will be touching the patient during the procedure. A third possible worry is that robot arms may fail to recognize unexpected emergencies. If there is something that goes wrong or something that isn't normal once a patient is opened, the robotic arm will continue to operate and not know the difference. When this is the case, the robot can cut or remove something that needs to stay intact in the human. People think there is more risk when a robot is operating because they do not contain a brain like a human to solve problems and make sure the patient comes out of surgery okay. Even Though the healing time, being less invasive and less blood loss are all benefits, there are still always going to be concerns with new technology.

To balance the two above worries, let us point out that robotic surgery might bring some unexpected benefits for the elderly population. As we described above, using robots in the medical field decreases the healing time after surgery, it is also less invasive, and the procedure time is reduced. The elderly population tends to require medical procedures and medical attention more than other populations. As people get older, their bodies tend not to work as fast and efficiently as they used to. When robotic devices are used to operate on these elder patients it will increase the

12

chances of their recovery. Elder people tend to heal a lot slower, and it is much harder for them to recover from medical procedure. There is a chance that these robotic devices can enhance the life of the elderly population five to six more years. That is six more years with the people that you love, and they will no longer be suffering once these medical procedures relieve them of their pain.

We will now have to move to our final area of robotic application – robotics in the workforce.

Part III

Robotics taking over the workforce

Before robotics became so advanced to be used in the operating room, they were initially used in warehouses and production lines. There are different types of robots in the workforce. According to the International Organization for Standardization there are four types of robots in use today – industrial, professional service, mobile and collaborative [26]. An industrial robot is defined as an automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications such as manufacturing, inspection, packaging, and assembly. Now almost every assembly line and conveyor belt have this. Professional service robot is a robot that performs commercial tasks outside of industrial automation applications. For example, a robot used in cleaning, delivery, firefighting, or surgery. We have already seen this type of robots in healthcare. Mobile robots are "robots that can activate and act under its own control." And finally, we have collaborative robots, a robot designed for direct interaction with humans, which we have seen in the nursing industry and now even in the industrial scene.

The industrial robots have been around since the early 1960s, when Joseph Engelberger created the first industrial robot Unimate [29]. This threw the whole car industry into a frenzy as General Motors became the first completely automated automotive company to use it [29]. They rebuilt one of their plants with just Unimates and were able to build 110 cars an hour which was over double the speed of any other automotive plant at the time [29]. This robot provided not only efficiency but replaced workers in dangerous work environments. Since then, engineers have used this as their model to create the perfect robot in all areas of the workforce.

One of the largest groups in terms of the workforce in the job market are the blue-collar jobs. These are physically intensive jobs that often require a lot of strength. For example, construction workers, miners, maintenance jobs, warehouse workers, etc. Blue-collar jobs have dropped from 31.2% in the 1970s to 13.6% in 2016 due to advancements in robotics and these statistics do not include agricultural jobs [28]. Studies show that back in the 1900s, agricultural jobs used to take up 41% of the workforce in the US [28]. By the year 2000, this percentage had dropped to 2% [28]. This is almost a 40% decrease of agricultural workers. Farms do not need horses or people to till the land anymore nor do they need workers to plant seeds, tend the livestock

13

or even harvest the crop. As you would expect, the increase in machine use on farms has pushed farmers into the city which has a higher cost of living than living in an outer town. While already pushing workers out of their jobs, they are also driving them into an area of high-cost living. They could try to move to another farming area or city but that is an expense in itself and all farming areas will eventually be fully automatic in the future. Besides agriculture, the replacement of people by robots is also seen in companies like Amazon, which is the second biggest company in the whole world that passed a trillion US dollars in net worth last year. Their warehouses all over the US are equipped with KIVA robots which do the same job that used to be done by warehouse workers.

While such robots are taking over the workforce, this might still turn out to be the better for society. A study shows that as manufacturing jobs are decreasing, manufacturing production is increasing. Manufacturing production has increased by 20% since 1975 while manufacturing jobs have decreased by 5% [28]. As you can tell, while robots are taking over a large majority of jobs, they are also producing products at a more rapid rate than a human. The average human spends 8 hours sleeping per day, while a robot does not have to sleep. The only expense you have to pay a robot is the amount of electricity it costs to run it and the initial cost to build them. If you think about it, robots build themselves on a conveyor belt. While being able to work 24/7, they also work 2-3 times as fast a human worker. Not only are they faster than human workers, but they are also stronger and do not need any breaks. They can work in dangerous environments and do jobs that we cannot do. Robots, unlike humans, do not get sick. Since these robots save money for companies, there would be more competition between big companies and prices would go down.

Along with being able to make products at a faster rate and being cost efficient, robots are also able to replace human workers in hazardous environments. According to the U.S. bureau of labor statistics, for every 100,000 loggers, 128 die each year on average [25]. Now, a logger is someone who cuts down trees and packs the wood to be used or sold. These are statistics back in 2012 and may have decreased due to technology which makes the work environment safer. This is quite a high number even when we compare it with the police officers. In 2012 there were around 55,300 working loggers, 64 loggers had died that year [25]. This same year, there were only 47 killed police officers, but this year the number of police officers was over 670,000 which is over ten times the amount of loggers and the loggers still had more deaths [25]. If cut down to deaths per 100,000 it doesn't even compare to the loggers' count. This is also not the only dangerous job that could be replaced, fishermen also have a high death rate, which is 117 deaths per 100,000 workers per year [25]. A more commonly known job that is also dangerous is a being a firefighter. Everyone knows that firefighters risk their lives in order to combat the fires that spiral out of control, whether it be in the city, in a forest, or even at a farm far outside the city. A recent fire that most have heard of is the fire that started at the famous Notre Dame cathedral in Paris which has an annual visitor count of 13 million, and has been around since the year 865 AD. According to *Insider News*, it took the fire department nine hours to put the fire out. The reason being that the cathedral was so old and made out of very flammable material. The fire had engulfed a large area and would have burned a lot of ancient artifacts if not for the brave firefighters who formed a

14

human chain to transport the priceless relics to safety. While they did save most, they could not recover everything. There is a priceless organ in the cathedral which organists must place themselves on a waitlist (that might last up to years) to play and most likely has been damaged from the fire since organs are such fragile instruments. There are other artifacts that have not been found yet that are rumored to have been lost. Around 400 firefighters were posted to handle this massive fire and among them were many servicemen and servicewomen. If you were to have replaced all of these servicemen and servicewomen with robots, there would not have been any risk of anyone getting hurt or dying. They would have been deployed around the cathedral and could have gone in to save every artifact in the massive building. You would not have to worry about the limitations of human beings, which is that we are not that strong, we can get burned really easily and we have emotions (e.g., fear) that can make us hesitate in a dangerous situation.
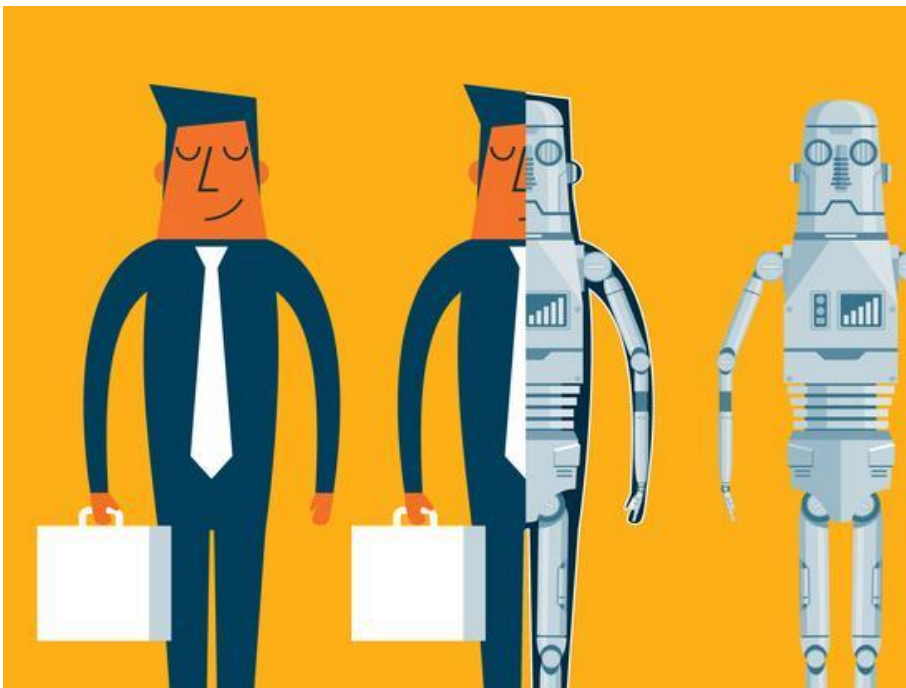
Figure 4: Working man being replaced by robot

The use of robotics can of course extend to other kind of jobs. In the United States of America, the most common job is that of a retail salesperson, and the second most common are fast food counter workers [31]. These are both service jobs. A study shows that 58% of American adults dine out at a fast-food restaurant a week. This just goes to show how important the fast-food industry is to the American culture. McDonald's is one of the most iconic American fast-food chains. It has been around since 1955 and has grown at an outrageous speed. At the moment it has over 14,000 restaurants in the United States alone [30]. Last year, McDonalds started to replace their cashiers with automatic touchscreen kiosks. A kiosk is a booth-like screen that customers can

15

order food from. These are how fast-food chain restaurants like McDonalds are starting to replace their workers with robots. Instead of having to train new workers, worry about workers quitting or even worry about workers at all, big companies are placing machines that do not have human frailties or even get tired. Along with the kiosk cashiers, other fast-food chains are even replacing the cooks, for example CaliBurger. This fast-food chain has replaced a few of its workers at one of its locations with "Flippy the robot." Flippy's only job is to flip burgers endlessly throughout the day. While this does only replace one job, its spread out throughout the day which means three or four people are being replaced by one robot since this robot does not need any breaks or time off. It even works what human workers think of "overtime" for free.

The downside of these non-stop working robots that can flip burgers, take charge at the counter etc., is that they cannot be emotionally there for people. If you order from a robot, you do not have the same interaction with it as you would with a human. If I were to go to a store, there are always employees who are looking to talk to you. For some people, these are the only human contacts they would have in a day. If we are to replace all the humans in a store, those places would literally become lifeless, and one would have to rely on the communication between customers in order to have some kind of social interaction.

One way for robots to be put into good use in the workforce is for them to be used to assist the senior members with physical jobs. The older you get, the less physically active you are. This is a commonly known fact that explains why over half the homeless people in the United States are over the age of 50. This is a large increase since the 1990s where the number was only 11% [27]. While this is partially due to their inability to save money (due to low wages) before they could retire, it is mostly due to them not having enough time to save the amount they needed to retire. Another study shows that homeless people in their 50s show the same difficulties that non-homeless people show who are in their 70s and 80s [27]. Now how could companies help these elders with their aging problem? We have already seen robots that could be used to assist the elderly in their jobs, for example the KIVA robots. KIVA robots are used in the warehouses of Amazon which is one of the biggest companies in the world. The way these robots work is that they are programmed to locate items in the warehouse and bring them to a certain area to be picked up and shipped off. This process could help an elderly person by eliminating the need to walk back and forth from the location of items to the packaging area. The elder worker would barely have to walk at all or carry any boxes – all they would need is to press a few buttons and make sure that everything is in order. This can give the elderly ability to work for longer years and keep them living in homes with independence and dignity.

The Two ethical Lenses: Kantian ethics and Utilitarianism

The two ethical views that we can now use to assess the use of robotics in the workplace are Kant's deontological theory and utilitarian ethics. Kant states that our actions should not be based on consequences but be driven instead by good will. This is a form of deontological ethics

16

which means that it is all about the intentions (as opposed to utilitarianism which is all about the outcome). This means one's actions are evaluated via one's motives and intentions. Now, everyone is raised in different environments and families might often differ in their customs, but reasoning is the same for us all. This is why Kant puts maximum value on intentions rather than outcome. If we were to apply this theory to the robots in the workplace, we shall have to look at the motives of the companies and not merely at their bottom line or outcome. If the head of the companies want to add robots just to capture more market share, then that would be morally wrong by Kant's standards, for they will be using thousands of smaller companies and workers as mere means. Even if they are attempting to reduce the amount of people, they are letting go by opening other jobs, if it is out of greed. However, if they were doing this for an ethical reason, it could still be ethically right.

As per Kant's framework then, extensive use of robotics in workplace situations then cannot be justified for it does not pass his maxims. There is no 'good will' on the part of the companies in such ventures. The other ethical theory is utilitarianism, and this states that an action is ethical if it produces maximum happiness in the end. This means that the ethics is based on the consequences and not the intention. This is very intuitive, especially when we use thought experiments like the "Trolley Problem" which asks if you were on a trolley and had to choose between running over five people or turning the trolley to run over one person. Either way you are killing someone, but in one scenario you are saving five and the other you are saving only one. Majority of people would save the five since it is "more" people and utilitarianism states that this is ethically right. In this case, taking millions of people out of their jobs means that all of them would be unhappy (if not all a large majority). Robots cannot feel any emotion, so they are not added in the list. The only people who are getting an increase in happiness are the company heads and whoever gets to keep their jobs in the company.

Robotics helping the workforce

Instead of engineers thinking of robotics as a way to replace people in common jobs, they can think of robotics to do those tasks that humans cannot do for they are dangerous and require great feats of strength. Humans will never fully be able to control how nature reacts, we can try and prevent or prepare for natural disasters. One of the ways we can prepare for this is to have servicemen ready to be deployed to rescue any civilians that are or will be in danger. If a tsunami is inevitable and surging to a city the servicemen would start evacuating everyone out of the city. Now they would also have to evacuate in order to not be swept up by the tsunami as well. If they did stay back, they would be putting themselves at risk in order to save a few, maybe not even any lives at all. Then, after the tsunami, they would be sent in to check for any survivors or missing people. Now imagine if we had robots to replace these jobs, they could stay back even during the event and continue to evacuate anyone still lingering in the soon to be affected area. If they are made well, they should also be able to take the full effect of the catastrophe or be swept away and

17

able to get back up unlike a regular human. During the aftermath of the tsunami, in the cleaning process robots will be able to lift heavy objects blocking areas (e.g., people trapped in basements, under rubble, etc.). Tsunami is just an example, but robots could be used in any disaster situations in general (e.g., in the Notre Dame fire). We already see robots are being used in the military to disable bombs and take the risk of exploding IED's instead of having an actual person doing it. If there is a car accident and the car is flipped a robot could come in and lift the car to save the person who might be stuck inside or underneath it.

Conclusion

The strong trend in the U.S. and across the globe is a rapidly aging population and a shortage of professional caregivers. Throughout application of virtue and care ethics much elderly care can provided by robotics, for they can take care of people around the clock, and accomplish a variety of tasks, even meet some of their social needs. They are thus a good fit in modern society for they provide advanced assistance with the elders' daily activities, reduce their social isolation, and even help maintain their independence and cognitive engagement. Along with helping with care, they could even assist an elderly person to make money. Not every elderly has someone to pay for their care and being able to work just a few years longer would help a lot especially with these elderly who are stuck on the streets. Thus, robots as a proxy for human care, and would effectively support modern successful aging. When used in the workforce, they could be more efficient in saving lives in situations where humans being would otherwise have to risk their lives. When looking at our ethical theories, Utilitarianism and Deontology, and their relevance to robotics in the medical field, we found that this will enhance the overall well-being and happiness of the population. When these robotic devices are used it will decrease healing time and allow people to return to work and their families. For the elderly who cannot find work due to their physical conditions, robots like KIVA (as mentioned before) could help them by taking over the physical aspect of certain jobs. Thus, the workforce robots could be a powerhouse in terms of protecting people, minimizing risks in dangerous jobs, and even just with productivity. All this will allow people to spend more time with their loved ones and be able to live longer and productive lives. Thus, it should not even be a question whether robots should be used or not. However, these ethical theories will allow us to successfully navigate the new technologies and create a happier and more virtuous society.

18

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19

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21