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ÚSTAV JAZYKŮ

HUMANOID ROBOTS: DESIGN, DEVELOPMENT AND APPLICATION
HUMANOIDNÍ ROBOTI: DESIGN, VÝVOJ A APLIKACE

BACHELOR'S THESIS
BAKALÁŘSKÁ PRÁCE

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Humanoidní roboti: design, vývoj a aplikace

POKYNY PRO VYPRACOVÁNÍ:

Popište a analyzujte charakteristické vlastnosti, vývoj a modelování humanoidních robotů a diskutujte jejich možnou aplikaci.

DOPORUČENÁ LITERATURA:

1) Perkowitz, S. (2004). Digital people: From bionic humans to androids. Washington, D. C.: Joseph Henry Press.

2) Eaton, M. (2015). Evolutionary humanoid robotics. New York: Springer.

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Vedoucí práce: Mgr. Ing. Eva Ellederová

doc. PhDr. Milena Krhutová, Ph.D.
předseda oborové rady

Abstract:

This bachelor thesis deals with humanoid robots. It describes characteristic features and historical development of humanoid robots, including the latest progress in their simulation, modelling and programming. The advantages and disadvantages of humanoid robots including their impact on our society are discussed as well, continuing with survey that investigates public opinion on this topic and interpretation of results as a practical part.

Keywords:

Artificial intelligence, humanoid, humanoid robot, robot, design, modulation, machine

Abstrakt:

Tato bakalářská práce se zabývá humaniodními roboty. Popisuje základní znaky humanoidních robotů a jejich historický vývoj včetně pokroků, kterých bylo dosaženo v oblasti jejich simulace, modelování a programování. Práce rovněž pojednává o výhodách a nevýhodách využití humanoidních robotů včetně jejich vlivu na naši společnost, na teoretickou čast navazuje praktická část, kterou tvoří dotazník zkoumající názory veřejnosti a interpretace získaných výsledků.

Klíčová slova:

Umělá intelligence, humanoid, humanoidní robot, robot, design, modulace, stroj

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Prohlášení

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V Brně dne..... .....

Alexandra Kovyrcheva

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1 Introduction

Humanity has been always trying its best to improve the quality of everyday life and work. During this process of improvement, a new class of machines arises – robots, and alongside with them a whole direction – robotics. Developers want to use robots not only for industrial purposes, but also in the domestic environment. Scientists hope that domestic robots in the coming decades will be as common in usage as smartphones.

Nowadays, people cannot imagine their everyday lives without different types of modern electronic devices. Regarding this fact that is compelling to discover more information about those machines.

The first part of this thesis provides an introduction to the historical background of ancient robots and also helps to understand intentions humans who constructed those. Also, there are visible changes of those intentions. The terms mechanism, robot and humanoid robot are distinguished here, according to the characteristic features of each of them. The historical part, which is devoted to the robots developed in Japan, contains the description of the modern humanoid robot Sophia.

Not only positive aspects of both humanoid robots and robots will be described in the thesis, but also the reasons why people are still scared of them. The last chapter of the theoretical part describes the modulation of a humanoid robot called Bionic Handling Assistant, problems with the modulation and their solutions.
The concluding part will summarize findings about history of humanoid robots, potential danger and importance to mankind and their designing from the literature review I have conducted.

Practical part of the bachelor thesis will continue in researching positive and negative aspects of humanoid robots on everyday life and society. I will create survey that will deal with opinion of people both with and without specialization connected to automation, robotics or artificial intelligence. Discussion of research findings in the practical part of the thesis will interpret obtained data and will make a conclusion

2 The concept of a robot

Before describing and discussing the very first robots, it is necessary to determine what exactly is meant by this concept. This is important for understanding the development of this technology and its uniqueness. The word "robot"[1] first appeared in Čapek's[2] science fiction play R.U.R[3] which stands for Rossum's Universal Robots.

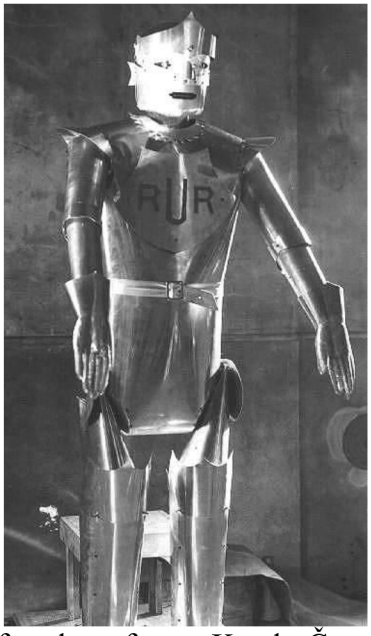

Figure 1. Illustration of robot from Karel Čapek's R.U.R.. Reprinted from: http://www.robogeek.ru/interesnoe-o-robotah/pervyi-v-mire-govoryaschii-i-hodyaschii-robot-erik-mozhet-vernutsya-k-zhizni

There it meant an artificially created person whose work was used in heavy and dangerous industries instead of a human. Although in this work robots were made in factories from grown organic fabrics, the concept itself was subsequently popularized specifically for mechanical devices.

Nonetheless, the robot should be distinguished from simple mechanisms. This device has the ability to interact with the operator and the external environment much more closely and comprehensively. A simple automatic mechanism, during a performance of a certain action, thoughtlessly follows the algorithm previously laid in it, whereas the robot is able to perceive external signals and adapt its actions in accordance with those signals. Thus,

[1] The term "robot" comes from the Czech language meaning "forced labour".
[2] Karel Čapek (1890–1938) was a Czech playwright, novelist and journalist.
[3] The play premiered on 25 January 1921 and introduced the word "robot" to the English language and science fiction as a whole.

its interaction with the external environment becomes more flexible, accurate and versatile. Even the very first robots in the world, which will be discussed later, had primitive analogues of the senses, without which this fundamental difference would be impossible.

Čapek created the word robot itself, however, Asimov formulated The Three Laws of Robotics, which were introduced in his story Runaround written in 1941:

- The First Law: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
- The Second Law: A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
- The Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

If we explored these laws deeper, we would realize that they follows the same basic principles as the majority of the ethical systems do. As the society knows, each person is endowed with the survival instinct, nevertheless, the Third Law might be considered as an analogy between a robot and a human. For instance, the person could carefully heed their medical doctor, close friend, colleague, government or psychiatrist; each person treating others with decorum, keeping the formal contact with acquaintances, fulfils the silent rules, given by the society. Those rules are strictly followed by any part of the civil society, as a result of feeling social responsibility and respecting certain authorities, even if they may dispossess a particular person of compostable life space.

According to the obvious reasons, robots are deprived of the social feelings, yet, they have the Second Law. Besides, it is assumed that every "good" person should love people around, protect them, furthermore, in a life-threatening situation, even risk an own life for the others. The previous sentence could be an interpretation of the First Law of Robotics. Consequently, when an anthropomorphic robot follows those three laws, it will be hard to distinguish them from a well-behaved person.

However, indeed, following those rules seemed hard. Even robots from the Asimovs' books are confused with the simultaneous implementation of all those Laws. In the story Runaround, Asimov (1950) clearly explained the conflict generated by different actions

dictated by two different Laws: This conflict starts with the opposite positronic potentials in the brain. As Speedy was walking into danger, positronic potential of the Rule 3 sets up turns him back. But he had an order to walk into that danger, hence Rule 2 sets up a counter-potential higher than the previous one and the robot follows orders at the risk of existence.

2.1 The concept of a humanoid robot

Regarding Rouse (2015), humanoid robots have to be designed to resemble humans. It means that humanoid robots have a body, two legs, two arms, and a certain shape of head. Some examples of modern humanoid robots can change face expressions in accordance with number of emotions they were constructed to be able to demonstrate. Although the idea of creating robots of this type has existed for a long time, only in the last decade has in fact been achieved quite a great success in the creation of relatively humanoid robots.
However, a truly humanoid robot should not only have an anthropomorphic appearance, but also needs to have specific abilities. For example, a simple calculator placed in a human-like body will not become a humanoid robot. Humanoid robots, as robots in general, were originally constructed to do tasks which are dangerous for people or only hard to be implemented by them.
The ability to move is one of the most difficult tasks in creating good humanoid robots, since the human body is actually quite a complex system in terms of its motoric capabilities. For example, it is incredibly difficult to create a robot that can jump, because to move a heavy robot you need a significant amount of energy, and adjusting and fine tuning the engines in order to maintain balance during a collision is extremely difficult. Nowadays, the problem with humanoid robots' movement is solved. For instance, the Bionic handling assistant (see Figure 2) considering which Nordmann, Rolf and Wrede (2012) claim:

> The Bionic Handling Assistant is a new continuum robot which is manufactured in a rapid-prototyping procedure out of elastic polyamide. Its mechanical flexibility and low weight provide an enormous potential for physical human robot interaction. Yet, the elasticity and parallel continuum actuation design challenge standard approaches to deal with a robot from a control, simulation, and software modelling perspective.

(p.113)

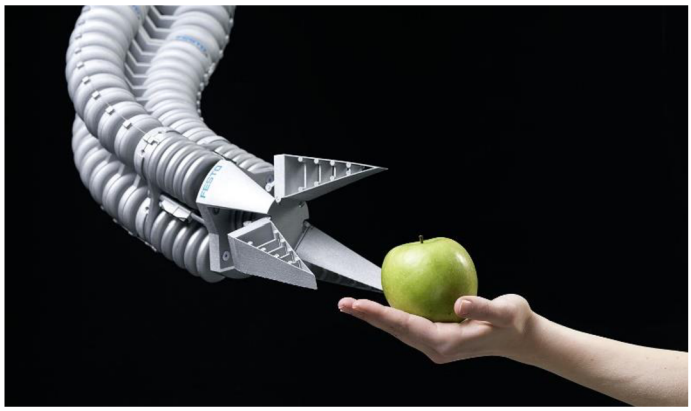

*Figure 2.*The Bionic Handling Assistant. Retrieved from: https://www.festo.com/group/en/cms/10241.htm

But even given the limited capabilities, humanoid robots already have a number of applications, and in the future, they will be able to solve many other important tasks. Humanoid robots can be used to perform hazardous work that requires human involvement. They can also be used to serve the elderly, care and entertainment for young children. Meanwhile, humanoid robots continue to improve, they can already replace humans in many cases, especially at working in space, under water, or when studying hazardous areas on the earth's surface.

3 Historical development of robot

The following chapters deal with the history of the process of robots development: from the very begging till the present time. For truly understanding the concept of robots and robotics we need, firstly, comprehend the aims for which they were originally created. What kind of ideas people were following when they were devoted their time and all other limited resources to creation of totally new product? Also the nowadays aims of having robots will be compared with the original ones.

3.1 BC era

The history of the creation of robots is deeply intertwined with the development of mechanics. Moreover, the robots creation itself logically stems from mechanics. During that time a lot of automatic devices were created either for implementation of practical tasks, entertainment or destroying enemies.

Well-known Greek inventor and scientist Archimedes (c. 287–212 BC) was also famous for creating automatic mechanisms. According to Shuttleworth (2011, September 2) he is credited with creating the first prototype of a real combat robot. The device, called "The Claw" (see Figure 3), mounted on the fortress wall, captured the Roman ships, attempting to besiege the city, with a long hook, lifted them into the air and turned them around, shaking the crew overboard. "The Claw" was mainly used during the Second Punic War.

Figure 3. The Claw. Retrieved from: https://www.mpoweruk.com/Archimedes.htm

However, in contrast with previously described examples, some inventions were useful not only for military aims. As an example, Greek inventor and physicist Ctesibius of

Alexandria (285–222 BC) designed the water clock or clepsydra ("water thief").
Nocks (2008) informs that clepsydra was used in ancient law courts to measure the time when a prisoner was speaking. It had a long tube plunged into the water and when it was full, the opening at the top was closed. When it was reopened, the water dripped through a small opening at the lower end. A person was free to speak until the tube was empty. The rate of flow increased when there was more water in the tube. As it emptied, the decrease of pressure slowed the dripping. Ctesibius used a three-tier system in which a large volume of water emptied into the clepsydra to insure it remained full. Clepsydra was the most precise and accurate clock ever constructed until the invention of a pendulum clock in 1656 (which means that for more than 1800 years that type of clock was usable).

3.2 AD era

Regarding Hero of Alexandrias' (c. 10–70 AD) contribution to the robotics, it is important to mention his name and discuss some of his remarkable inventions. Hero is related to the greatest engineers in the history of mankind. His name is widely famous and recognizable as a result of his published description of a steam-powered device called an "aeolipile" (sometimes even called after him – a "Hero engine"), first vending machine, temple door opener, the Dioptra and etc. (Shuttleworth, 2011). All of the above listed facts from Hero's biography are widespread and recognizable. However, the following invention that could seem hardly enough remarkable, indeed still crucial, is the first vending machine.
During the whole Age of Antiquity, religion had a great influence on people. There were plenty of temples and churches throughout the entire territory of Europe, consequently each person went to communicate with God wherever they liked. Since the well-being of priests of any temple depended on the number of congregations, the priests tried to lure them with anything. According to this way, they discovered a law, which still operates today: Nothing attracts people to go to the temple better than a miracle does. However, Zeus did not descend from Mount Olympus more often than heavenly manna fell from the sky, nevertheless the congregations had to be lured to the temple all the time. To create handmade wonders, the priests had to use the intelligence and scientific knowledge of Hero.
One of the most impressive wonders was the mechanism he developed which opened the doors of the temple while kindling fire on the altar. According to Shuttleworth (2011), the air heated from the fire entered the vessel with water and gradually letting the water in little

by little into a barrel suspended on the rope. The barrel, being gradually filled with water, went down and, with the help of a rope, rotated the cylinders that made the front doors opened. When the fire extinguished, the water returned from the barrel into the vessel and the counterweight suspended on the rope, which was also rotating the cylinders, closed the doors. Sufficiently simple mechanism, however the congregations were deeply impressed. Another Hero's invention that significantly increased the profitability of ancient temples was the vending machine for selling holy water.

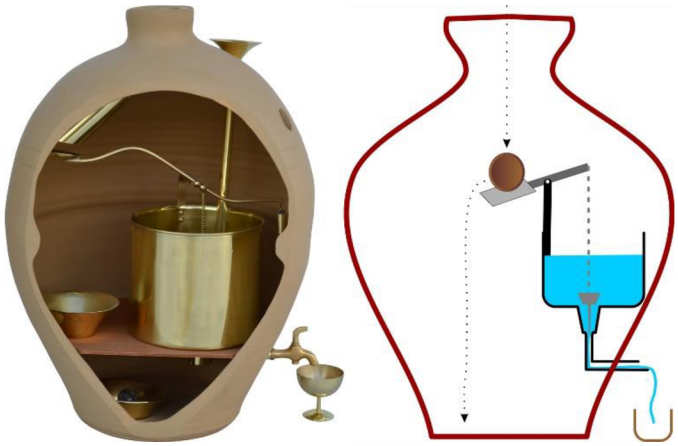

*Figure 4.*Vending machine. Retrieved from: https://pikabu.ru/story/inzhener_drevnosti_geron_aleksandriyskiy_5367482

According to Andrews (2018) the internal mechanism of the device was truly elementary, and consisted of a precisely balanced lever that controlled the valve, which opened under the influence of the weight of the coin. The coin fell through the slot on a small tray and actuated the lever and valve. The valve opened, leaking some water. Then the coin slid off the tray, and the lever returned to its original position, closing the valve. This invention epitomized the first vending machine and, despite the fact that it brought a good profit, was forgotten for centuries. Moreover, only at the end of the 19th century, vending machines were invented again.

3.2.1 Renaissance

During the Renaissance period, scientists were really interested in inventing automatic watch movements and human figures that moved. The whole story of robotics could be

hardly imagined without the name of Leonardo da Vinci. His contribution to this field of science definitely is valued and even difficult to overestimate. Approximately in 1495, he created a mechanical robot knight (Leonardo's robot or Leonardo's mechanical knight).

Figure 5. Leonardo's robot. Retrieved from: https://www.xatakaciencia.com/robotica/el-robot-que-construyo-leonardo-da-vinci

According to the Leonardo da Vinci robot society (2008) this robots was consisted of a knight armor, which was fitted with gears, wheels and pulleys. It was controlled using cables and pulleys. This robotic knight could lift its visor, sit or stand and could move its head. It was an anthropomorphic robot fully dressed in medieval metal armor. Inside it there was a complex mechanical system that made the knight move limbs. The robot was able to sit, stand, move its arms and neck, as well as open the jaw, which was anatomically very similar to the human. Judging by the drawings, two separate mechanisms set the robot in motion. One was responsible for the upper limbs and head, the other for the legs. Everything worked through the interaction of scales and liquids.

For the first time, the robot was presented at the celebration of the Duke of Louis Sforza in Milan in 1495, and in the 20th century, according to the newly acquired drawings, da Vinci made a copy of the automaton that was fully functional.

3.2.2 20th century

The next huge step in the history of robotic took place in the 20th century. It was closely connected with expeditious development of the cultural life. The technical progress starts to rapidly invade more and more areas of human life. Since literature, theatres plays and

cinematography always represent people being from different points of view, these areas had to reflect the technical progress too.

As it was mentioned before, in 1921 the first robot was appeared in Čapek's theatre play named *R.U.R.* (*Rossum's Universal Robots*), which gave people not only the term robot itself with an idea of what the robot was made for, but also a description of the rise of the machines what may happen in the world which would possibly be full of robots.

The first humanoid robot to appear in the movies was Maria in the film *Metropolis*[4]. The film shows the conflict between the rich employers living in the high-rise towers and the underground-dwelling workers who were working under the great machines that power the city. Perkowitz (2004) describes the idea of substation human for robot from film Metropolis as "the weirdly alluring female robot that becomes the debased double of a human is a fantastic intersection of human and machine, with powerful emotional underpinnings."(p. 29).

The play and the movie were premiered almost at the same time which means that the idea of interacting with robots during the everyday life or even substitution people by robots was spreading into the community, generally.

In 1939, a robot named Elektro (see Figure 5) was created by the Westinghouse Electric Corporation. According to Denny (2016), it had several moving abilities to be done. For example, it could walk, move its arms and head and move around on a wheel in its base. As far as ability to walk is concerned, Elektro could not move the whole leg, it was only rolling on its rubber tire rollers. In addition, Elektro was constructed with photoelectric eyes and could distinguish between red and green light. As it was able to play the recorded speech (700 words), Elektro produced the word green or red when it distinguished them. It was the first robot, responding to voice command, even considering it could comprehend a definite amount of commands, it was a huge progress and step forward. In 1940, the Westinghouse Electric Corporation created a small dog robot Sparko for his robot Elektro. Sparko was able to walk, sit and stand as well as bark and wag its tail.

[4] A German expressionist science-fiction silent film directed by Fritz Lang that was premiered in 1927.

Figure 6. Westinghouse Robot Elektro & Robot Dog Sparko. Retrieved from: https://www.worthpoint.com/worthopedia/1955-westinghouse-robot-elektro-robot 252901252

Obviously, it was a huge step further from the da Vinci's time; however, Joe Denny (2016) states that, the sketch of his robotic knight was used by mechanical engineer Mark Rosheim[5] for building a prototype of the same robot in 2002. He further modified it and made it more advanced by introducing its ability to walk without any help of wheels or pulleys.

[5] Mark Rosheim is founder and president of Ross-Hime Designs, Inc., a Minneapolis, Minnesota-based mechanical design company. He is the author of a book Leonardo's Lost Robots (Springer, 2006).

4 Historical development of humanoid robots

Since the Age of Antiquity European countries have been keeping the leadership in almost all essential areas of human life. However, robotics is expeditiously developing not only in Europe and the United States, but also in Asian countries. Nowadays, high technology is one of the main associations connected with the Land of the Rising Sun. There are various electronic devices are used in various fields: from commercial manufacturing to helping the elderly, leaving this outside, all Japanese technologies, including robots, will surprise even the most pernickety user with their capabilities. New Japanese robots immediately become the subject of attention of the media, various enterprises and normal users of progress and robotics from the whole world.

WABOT-1

The history of Japanese humanoid robots started in the 1970s with WABOT-1, the given name leads to WAseda roBOT, was developed by Ichiro Kato et al. from Waseda University in 1973.

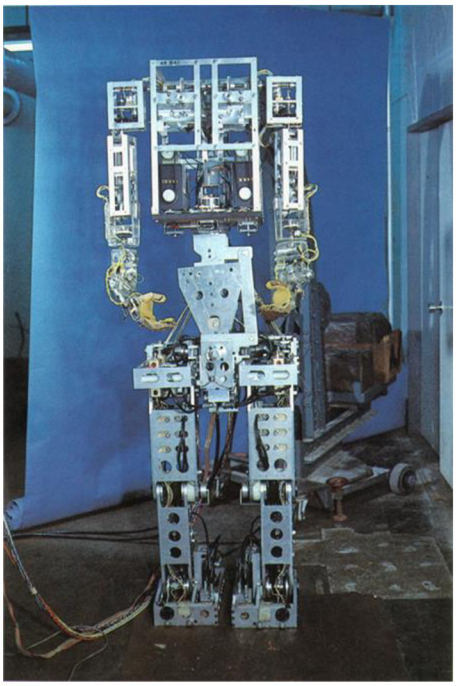

Figure 7. The first humanoid robot WABOT-1.
Retrieved from: http://www.humanoid.waseda.ac.jp/booklet/kato_2.html

This robot was the first robot able to understand human speech, walk by its legs (not rubber tire rollers, as Elektro did) and to transport things with the help of its hands. Kajita (2014, p. 156) claims that Wabot-1 should be called the first humanoid robot in the history, according to its appearance and abilities. This statement is definitely logical concerning the fact that WABOT-1 included many innovations and improvements. Kajita (2014, p. 2) also describes the most crucial characteristics of WABOT-1 including:

- recognizing objects by vision,
- manipulating objects by hands (existence of tactile sensors),
- understanding spoken language,
- speaking by artificial voice,
- walking on biped legs.

WABOT-2

In 1984 the same group of scientists, who created WABOT-2, from Waseda University, decided to develop robot WABOT-2, with one crucial difference. Scientists wanted it be able to play the keyboard musical instruments, therefore WABOT-2 became famous for playing piano.

Figure 8. WABOT-2.
Retrieved from: http://www.humanoid.waseda.ac.jp/booklet/kato_2.html

Sophia

Considering one of three aims of the thesis it is vital to analyse modern humanoid robots, to mention how different they are from their predecessors. Logically, people changed their goals for making humanoid robots. Hence, it is crucial to describe modern examples of robots.

Even one hundred years ago before now, people could not assume an idea of keeping a reasonable conversation with a robot. Humans' opinion stayed the same till Sophia was created. Regarding Chung (2018) a new humanoid robot Sophia developed by David Hanson, the founder of Hanson Robotics, is an anthropomorphic robot designed with several abilities, making it more human-like. Corey (2016) states that "primary function, as it eloquently told the audience itself, is to communicate with people". Sophia's human-like appearance supposed to be a powerful argument in a in the fight against perception people used to have. According to this way, the robot will have more chances to dial with its primary task.

Figure 9. Humanoid robot Sophia. Retrieved from: http://saudigazette.com.sa/article/533117/BUSINESS/Etihad-airways-to-host-ai- robot-sophia-at-ATM

As public appreciates Sophia, it headlined major of tech conferences, for example,

CNBC's[6] Andrew Ross Sorkin interview with Sophia about the future of AI[7], where Sorkin also congratulates Sophia with an important award of Saudi Arabian citizenship. Sophia owns several unique qualities which make it a special example of AI in real life.

First, it possesses an anthropomorphic appearance. Corey (2016) states that: "Sophia is a robotic head designed by Hanson that looks almost, but not quite human. Its design was based on Audrey Hepburn and Hanson's own wife." Its skin resembles humans what also helps Sophia be closer to humans. People would be pleased to meet someone similar to them in their everyday life, rather than someone completely different. Thus, Sophia's appearance is closer to humans, and humans are ready to see robots like Sophia in their lives.

Second, it is able to make a conversation with people in a fluent manner. Sophia has already participated in many TV programs all around the world. This confirms that she is able to freely maintain a conversation. Corey (2016) claims that voice technology allows it to verbally respond to humans and even large information technology companies like Intel and IBM are exploring how to integrate some of their own advanced artificial intelligence systems and into the robot to test it.

Third, it can form 62 facial expressions what makes people think that Sophia, being a humanoid robot, is similar to them. That is a well-known fact, that people use nonverbal communication normally, for example, to express emotions. As facial expressions are a part of people's communication, they will be more willing to keep a conversation with a robot like Sophia which could react to their speech or situation around.

Urbi (2018) explains that from a software point of view Sophia is a platform for something, what means that it is possible to run a lot of different software programs on that very same robot. Also, Grabaskas (2018) noticed that Sophia has three different control systems: Timeline Editor, Sophisticated Chat System and OpenCog. Timeline Editor is basically a straight scripting software which responds for all information Sophia needs to say. The Sophisticated Chat System allows Sophia to pick up on and respond to key words and phrases, based on a context. And OpenCog the most progressive system from those three, it makes Sophia's' answers be based on the past experience and previous conversations.

[6] CNBC refers to Consumer News and Business Channel.
[7] AI refers to artificial intelligence

In this chapter, I briefly discussed the history humanoid robots development. From the first example WABOT-1, the construction of which was relatively simple, till one of the moderns' example named Sophia. Also, I explained the functions and differences between them, hence the progress is perceivable. However, the whole topic concerning humanoids is ambiguous, for this reason I devoted the next chapter to the revealing of the negative aspects and further discussion of them.

5 Potential risks of a humanoid robot

Advantages of the humanoid robots are mostly obvious and a lot of them were mentioned in previous chapters of this thesis. Humanoid robots can do a lot of dangerous work instead of people, thus people protect their own lives and health with help of these machines. Also some of them were constructed for entertainment purposes, for example WABOT-2.
Nonetheless, if humanoid robots' existence promises humanity such sustainable future, why would people be afraid of humanoid robots? What kind of problems may arise with using humanoid robots in everyday life? Reasons might be different.
Turchin (2018) classified and explained some ways for AI to become dangerous and cause global catastrophe:

AI will become dangerous when it gets the capability to act independently in the wild (probably in the Internet) and perform better than humans in most human tasks. Such a capability will probably be based on the ability to create powerful world models and natural language processing. Thus, by measuring progress in NLP8 and world modelling in AI, we could estimate the creation time of such systems. (p.2)

Natural language processing, or NLP[8] is a necessary part of AI, which enables computers to process and, consequently, comprehend humans' speech. Indeed, that is how people can be sure that computer, created with the induction of AI, understands their intention, however that is no guarantee that the computer will always be agree to implement each particular users' intention.
During the previous century, humanity had directly experienced the disasters of two world wars, to this extent people are strongly afraid of the next worldwide armed conflict. Previous two world wars have passed without the intervention of AI, still both of them have led to a great loss of humanity life. Turchin (2018, p. 2) formulates the people's fear of humanoid robots participation in the development of military weapons as:

Another type of dangerous AI is that it could help facilitate dangerous research in

[8] NLP refers to natural language processing.

fields such as biotech or increase the effectiveness of existing military technologies. The perspective of future existence of increased effectiveness of military technologies connected with ideas belong to smart robots which do not strictly follow humans intentions obviously scares people. People are afraid that all of humanoid robots or any machine using AI one day may turn against its creators. Moreover, if those people are right, it will mean that we, by ourselves, created a weapon killed us. This fear is understandable and clear, humanity are normally afraid of being destroyed.

Fortunately, these concerns have nothing in common with nowadays perceivable reality. However, it does not mean that humanity has no problem connecting with different kinds of technologies. During the Industrial Revolution[9] a lot of machines which substituted hand production methods, for example spinning jenny[10], were invited. In this degree many people lost their work places, consequently, money for living. That is how many occupations, for example a switchboard operator, who connected calls by inserting a pair of phone plugs into appropriate jacks, were lost in the past. Indeed, people created all machines which they were against off after. Now we know that we achieve also positive coincidence of the Industrial Revolution, but that is an example how machines, originally made for improving peoples life, promote the revolution.

[9] The Industrial Revolution was the transition to new manufacturing processes in Europe and the US, in the period from about 1760 to sometime between 1820 and 1840. This transition included going from hand production methods to the development of machine tools and the rise of the factory system.
[10] A multi-spindle spinning frame. One of the key developments in the Industrial Revolution. It was invented in 1764 by James Hargreaves in Stanhill, Oswaldtwistle, Lancashire in England. The device reduced the amount of work needed to produce cloth.

6 Modulation of the Bionic Handling Assistant

This chapter deals with the analysing of modulation and simulation of a humanoid robots. I will use robot named Bionic Handling Assistant (hereinafter BHA) as an example. Nordmann (2012) mentions two main problems considering the modelling of this type of robot. The first one concerns a software, the second heterogeneous hardware.

To achieve the better functionality with a humanoid robot like the BHA[11], it is important to have a software model that will allow the robot to navigate itself in space and control its segments independently on other, but also co-ordinately. As the BHA has a shape of a long tentacle, it is necessary to have a length controller, but in a such modulation it is not possible to do it with a standard PID[12] controller which enables connect and disconnect functions to and from the control process. Thus, the robot has no length controller and for continue the simulation it is necessary to fix it. Solution of the problem is a software model that simulates the whole robotic arm in control software, this solution allows to measure length of simulated arm, as well as provides other sensing capabilities (Normann, 2012, p.115).

In order to check whether the Programming Model is able to deal with the problems with software and hardware, Nordmann (2012) describes the modulation of the BHA with RCI[13] abstractions. There is a necessity to discover how is it possible to provide reasonable semantic abstractions of the continuum kinematics which is performed by tentacle in this case. The RCI concept of a synchronizer is able to cope with the heterogeneous hardware interface setup of the BHA and provides meaningful hardware abstractions. Nordmann (2012) describes the functions of three different layers (resource nodes) which solve the software problem by modelling of the semantic abstraction:

> A chamber node represents a bellow actuation unit of the robot, equipped with length sensing. A segment node repeats the length sensed values and the pressures of its three chambers. The segments provide the three chamber length values in order to

[11] The BHA refers to the Bionic Handling Assistant.
[12] A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism widely used in industrial control systems and a variety of other applications requiring continuously modulated control.
[13] Robot Control Interface (RCI). RCI provides a set of domain-specific abstractions to represent common features of compliant robotics systems.

> provide a basis for later-on extensions with control capabilities. The end-effector node is the gripper, which position in Cartesian coordinate system is sensed. This is part of robot that is used for manipulating with objects and it also makes the robot usable. (pp. 117–118)

The implementation-specific part of the robot system is modelled as set of synchronizers (sensors) that have to deal with the problems connected with hardware. Those synchronizers are needed to control and sense. There are pressure and length synchronizers and Vicon motion tracking system. Nordmann (2012) describes functions of those synchronizers as following:

> The pressure synchronizer reads pressure commands from the chamber resource nodes and sends them to the responsible valves-unit. The length synchronizer accesses the driver of the analog-digital converter on PCI card on the controlling machine for reading values of the cable potentiometers at the outside of the bellow actuators and writes them to the chamber resource nodes. Motion tracking system runs on a different workstation, because it needs more performance. It connects to the Vicon motion tracking server and reads the current position of end-effector in coordinate system. (pp. 117–118)

Regarding Eaton (2015) there are two different approaches to evolutionary robotics[14]. First, robots may be classified from the perspective of the level of their bio-inspiration, that means how much were their creators inspired by biological processes, body construction and functionality of human or animal being (exactly the BHA example, which was heavily inspired by elephant trunk) This is also suitable for humanoid robots and other robots inspired by living creatures as was mentioned above. Second, we can classify them from the perspective of level of realization. The second category moves from simple control algorithms, which means "control and particularly feedback control of autonomous robots" (Eaton, 2015, p. 9), to simulated creatures, which have certain defined structures but still do not generate their motion and to those robots that observe a correct physical model the

[14] Evolutionary robotics (ER) involves the application of evolutionary techniques to the generation of either the "brain" (control systems) or to the "body" (morphology) of autonomous robots, or perhaps both.

last step being robots with an actual physical realisation in a real embodied robot (like Sophia).

It is necessary to mention, that these levels can be used together simultaneously. Eaton (2015, p. 22) states, that it is often used in robot development to evolve control structures and robot morphologies inside a dedicated simulator with accurate physic and thermal models. Then realization of this evolved simulated system into the real machine for verification of correctness and functionality and for implementation for normal use.

7 Conclusion of the theoretical part

In the theoretical part of this thesis the history of the development of a robot as well as of a humanoid robot was analysed. Regarding this information, it is possible to conclude that humanoid robots were developed to facilitate everyday human life in many different aspects. As it was investigated before, either robots or humanoid robots are getting better with the primary tasks they were made for. Regardless of the fact that robots are developed to help us, people have several reasons, such as loss of occupation or mistrust of artificial intelligence, to fear them.

I chose the Bionic Handling Assistant, as an example, to show some problems with robot modulation and construction. During the modulation of the BHA, two problems appeared that needed to be solved for the robot to work correctly. It was impossible to use a standard PID controller, because of the shape of the bionic hand and its necessity to navigate itself in space. The problem was solved by dividing the control system into three layers (nodes). Chamber node, segment node and end-effector node are linked, but each of them is controlling its own part of the robot body. Three types of sensors were used to navigate in space - pressure ones, length sensors and motion tracking system by Vicon company.

In the following practical part of my thesis, I would like to realise a survey to investigate public opinion on humanoid robots, their development and possible threat to humanity. I want to confirm or disprove the biggest fears of humans of humanoid robots and find out their opinions on this topic.

8 Practical part

8.1 The aim of the research

The main objective of the practical part is to understand people's attitude to humanoid robots' intrusion into their everyday life. The theoretical part left some questions related to people's attitude to humanoids. Hence, it is reasonable to make a questionnaire survey based on those questions. In Chapter 5 potential risks of humanoid robots were discussed, thus the research is conducted on this basis.

The main goal of the research is:

To understand the possible ways how people and humanoids may live together, regarding people's opinion.

The sub-goals of the research are the following:

1) To examine a hypothesis predicting that people are afraid of humanoid robots because of different reasons described in Chapter 5. For example, do people really think that one day humanoids will start to act independently from their creators or will they anyhow influence military effectiveness, again, without people's control?

2) To explain how people imagine their future life with robots around, also to understand what role, regarding to people, robots play now, as well as how this role may change in the near future. To implement this, I will ask respondents if they can imagine their life together with humanoids like Sophia or the BHA.

3) To compare the differences in data achieved from one questionnaire from two groups of respondents.

The possible variants become clear from discovering what kind of roles people allow humanoids to occupy. Regarding those roles, I will understand what type of robots people

prefer to see nearby, if they prefer to see any, of course.

In the following chapters, I will describe the phases of the research and analyse the data I will be provided with.

8.2 Phases of the research

The research pattern is composed of three main phases: preparation phase, realisation phase and evaluation phase.

8.2.1 Preparation phase

At this phase, it is vital to explain why I decided to design a questionnaire itself. The reason is simple, I needed to become acquainted with and, after, to understand the audience attitude to possible humanoid robot integration to humanity world. For this purpose, I also need to evaluate peoples' general knowledge considering this topic. After the main questions had been established, I concentrated on recruiting an appropriate respondent group and a data collection method.

Research samples

I decided to use both random and purposive sample methods because I find it necessary to discover the difference in the attitude to humanoid robots between two respondent groups.

The first group consists of 18-26 year old students studying IT or automation in the Czech Republic. The questionnaire I conducted for them was in the English language, thus, according to their fields of study, they supposed to provide me with more reasonable

answers. While the second target group is significantly different, their age category starts also from 18 years, but I paid more attention to the audience above 35 years old. Here, I also need to mention that their occupation has nothing in common with IT or humanoid robots modulation or automation in general. To cover a wider audience for the second group, I decided to use my knowledge of the Russian language, so I conducted one more questionnaire in Russian for them. I suspect that the answers I will achieve from the first respondent group will be more reasonable and knowledgeable because of the appropriate field of study.

Data collection tools

As it was described before, I chose two target groups of respondents and conducted one questionnaire. However, because of the second group I needed to translate the questionnaire into Russian that is why, indeed, I will have to collect and analyse data from the two questionnaires.

To alert more attention to my survey, I find it necessary to share the questionnaire on a several Facebook and Vkontakte pages, for example both of my personal pages and the page of the Brno University of Technology students group called Purkyňovy koleje (VUT Brno). As participants of this group study subjects closely connected with the topic of this thesis, they automatically answer to the main criteria of my first respondent group.

I decided to create a questionnaire survey with aim to collect necessary data. Exactly this method allows to collect data for future analysis easily and quickly. I decided to use Software service Survio® because it appealed to me most appropriate for this purpose. Also, as it was mentioned before, I decided to base my investigation on two target groups.

To reach the second group, I share the questionnaire on Vkontake pages, such as Администрация Одинцовского муниципального района (The Odintsovo municipal area administration) with Russian translation there. The main reasons of this research could be described as: discovering, processing and comparing the attitudes of two different groups of people who have already encountered robots, humanoids and AI.

In order to understand the exact position of both representative groups fully, I decided to include some open ended questions in the questionnaire. At the begging of designing my questionnaire, I thought that I would ask open questions only to the first group, however understanding that if humanoid robots one day become as popular as smart phones are now, I also need to know ordinary people's attitude to them. Besides, those questions are supposed to help me to discover the level of representatives comprehending the required information instead of their guessing, which, indeed, might take place in multiple choice questions.

Even if the education level of the second group might not seem appropriate, there was a sense to ask them those questions because the main goal of the research is to understand how people imagine their lives closely to humanoid robots. Considering this information, I decided to ask both groups the questions with the extended answers expected.

8.2.2 Realisation phase

Initially, I was thinking of conducting a more complicated questionnaire for the first group of the respondents in order to receive more topic-related feedback. I thought that I would provide only students group with open-ended questions, yet, I decided to ask both the groups exactly the same ones with aim to compare their answers and explain the differences that may arise. For this reason, the questions that I offered, had to be formulated in an extremely clear and understandable manner. A pilot version of the questionnaire had to be modified a few times and because of this the final version appeared perfectly understandable to everyone. Consequently, the participants from both the groups were willing to complete the task.

According to both my personal opinion and recommendations that were given, the final version of the questionnaire was posted on the web-page (see Appendix: Questionnaire). For gathering the basic information I created a number of close-ended questions which are also important to this survey. For example, it is not possible to ask people directly why they are afraid of humanoids until I am sure if they truly are. I included one question with a possibility to choose more than one option, because the aim of this question was to discover how many of the listed samples people know.

Nonetheless, to realize all the goals identified, data were acquired from open-ended questions, which appeals more crucial. People were asked to express their own opinion about a hypothetical situation with a robot presence in, and people had space to write down everything they wanted. Regarding this strategy, I collected the audiences' important thoughts and ideas to interpret them after.

Obviously, both types of questions were connected with neither the main goal of the thesis nor, at least one of sub-goals.

8.2.3 Evaluation phase

At this stage, it was necessary to divide all the respondents into two separate groups, according to their age, permanent place of residence and current occupation, because after that I needed to compare the collected data. The next step constituted a classification of open-ended question answers of each group: similar answers from the group were combined together and analysed separately from the opposite answers. Also, data were evaluated regarding the frequency of each answer occurrence in the offered questionnaire. Those combined data from both the groups were later compared with each other. Differences, as well as similarities, were interpreted and analysed together with the possible reasons of both existence.

8.3 Data analysis and interpretation

Question 1. What is your occupation?

As it was impossible to predict all possible occupations for both the groups, I decided to give the audience some space to answer. I asked 97 respondents as a whole, 56 representatives of the first group and 41 of the second.

The first group:

Here the situation occurs obvious because of the data collection tool (the student's group on Facebook) I used.

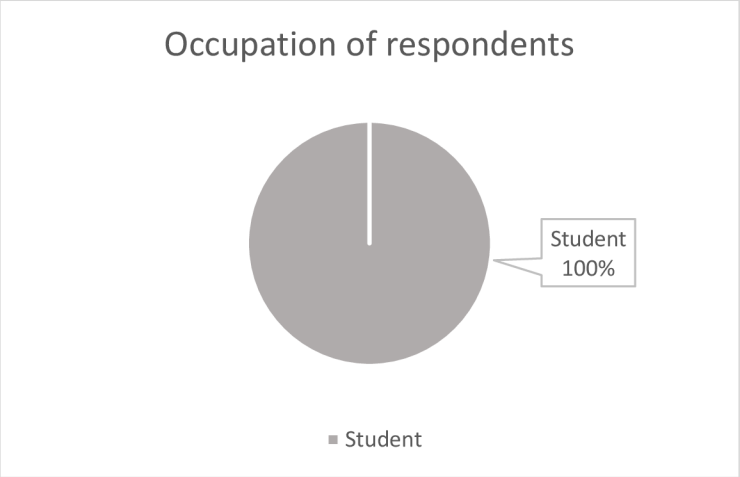

Figure 10. Occupation of respondents. The first group.

The second group:

The 41 respondents from this group provided me with more varying data; there were some answers several times repeated: lawyer, manager, teacher and veterinarian. However, there were more options listed, for example: nurse, housewife, sociologist, psychologist, realtor and many other occupations.

As it was discussed in the previous chapters, the difference in occupations is visible, thus I suspect that this factor will influence the answers listed below.

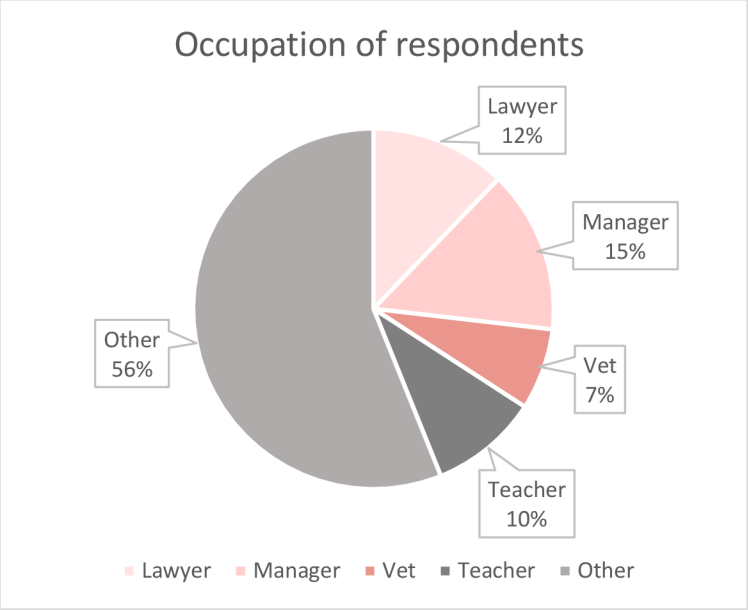

Figure 11. Occupation of respondents. The second group.

Question 2. What is your age category?

The first group:

Table 1. *The age category of respondents. The first group.*

Age category (years old)	Respondents	Respondents (in percent)
18-26	49	87,5
27-35	6	10,7
Above 35	1	1,8
Total	56	100

Most common age category: 18-26 years old (87,5 %)

The second group:

Table 2. The age category of respondents. The second group.

Age category (years old)	Respondents	Respondents (in percent)
18-26	8	19,5
27-35	10	24,4
Above 35	23	56,1
Total	41	100

Most common age category: above 35 years old (56,1%)

According to the third sub-goal that was described in Chapter 8.1 The aim of the research, I needed to create two groups of different age for further investigations. Those tables above clearly demonstrate us the achievement of this step.

Question 3. Do you know any of listed examples of humanoid robots? Mark each you know.

Here the respondents were allowed to choose more than one option as their answers, what obviously influenced the percentage, hence I decided to eliminate the column “Total”.

The first group:

Table 3. *Public awareness of the most famous humanoid robots. The first group.*

List of humanoid robots	Respondents	Respondents (in percent)
WaBOT-1	3	5,4
WaBOT-2	6	10,7
The Bionic Handling Assistant	21	37,5
Sophia	46	82,1

The second group:

Table 4. *Public awareness of the most famous humanoid robots. The second group.*

List of humanoid robots	Respondents	Respondents (in percent)
WaBOT-1	7	17,1
WaBOT-2	4	9,8
The Bionic Handling Assistant	12	29,3
Sophia	18	43,9

I included only those robots that were described in the theoretical part of this thesis, and the majority of both the groups recognized the most famous sample – Sophia.

Sophia participated the number of TV shows, for example CNBC's Andrew Ross Sorkin interview which had already been mentioned in Chapter 4 (Sophia). Also, this humanoid was invited to the famous Russian TV show named *Вечерний Ургант* (Evening Urgant,

2017), where the host of the show, Ivan Urgant, paid particular attention to the fact that he would interview the first humanoid gifted with anthropomorphic appearance.

Question 4. Do you think that one day in the future humanoid robots will be able to implement all (or almost all) humans work?

The first group:

Table 5. *Public awareness of the humanoids possible intervention in the human job trade. The first group.*

Options	Respondents	Respondents (in percent)
Yes.	11	19,6
No.	11	19,7
Yes, but not all.	34	60,7
Total	56	100

The second group:

Table 6. *Public awareness of the humanoids possible intervention in the human job trade. The second group.*

Options	Respondents	Respondents (in percent)
Yes.	14	34,1
No.	3	7,3
Yes, but not all.	23	58,5
Total	41	100

As far as this question is concerned, the option "No." appeals to me less reasonable because it is based on the events of the Industrial revolution. The substitution of hand production methods for automation presented positive and negative aspects simultaneously. Albeit, this question allows to express each of the respondents' opinion, and in both the groups there are people who chose this option for their own reasons.

Question 5. Are you afraid of humanoids?

The first group:

Table 7. *Rate of respondents fear from humanoid robots. The first group.*

Options	Respondents	Respondents (in percent)
Yes.	14	25
No.	42	75
Total	56	100

The second group:

Table 8. *Rate of respondents fear from humanoid robots. The second group.*

Options	Respondents	Respondents (in percent)
Yes.	17	41,5
No.	24	58,5
Total	41	100

The feedback achieved from this question is clear and understandable because till now any humanoid robot has never injured any person, that is why no reason to be afraid is perceived.

Nonetheless, the minority of the respondents look further and find important reasons to

be scared about. Thus, I decided to ask the next, pointed question in order to understand their reasons fully.

Question 6. Do you think that people should be afraid of humanoids? If yes, please give the reasons why.

The first group:

Having received 14 extended answers from students who feel fear of humanoid robots, the similar answers were combined together and written down as one.

Respondent 1: *"If they will be programmed for making some damages, they will do it."*

Respondent 2: *"I think we just need to be cautious with the design."*

From those responses I can conclude that those students think carefully about the design, modulation and software construction of robots. Each of the humanoids including AI needs to be programmed rigorously and also each humanoid will strictly follow the instructions laid into it.

The second group:

Respondent 1: *"I am afraid they will get out of control and become uncontrollable."*

Respondent 2*: "Robots are superior to man morally, physically and intellectually. People will eventually lose their competitiveness against them; it can make a man be a slave to a robot."*

The second group expressed more fears connected with humanoids. They are definitely afraid of hypothetical sequence of actions similar to an AI takeover scenario created by science fiction.

Question 7. Do you think that humanoids will start to think independently from their creators (people)? Give the reasons why.

I designed this question as an open-ended one because I wanted to know either answer – yes or no – or explanation.

The first group:

Respondent 1: *"Maybe, depends on the structure of the code, design."*

The second group:

Respondent 1: *"Yes, nobody can exclude a chance of system failures."*

Respondent 2: *"AI can perform a lot, but it will always do what it was programmed for."*

From the Tables 7 and 8 I concluded that the majority of the audience do not afraid of humanoids. However, relying on the replies gathered here, I conclude that people from the both groups have divided into two groups according to their opinions. One group stated that the three Laws of AI stated by Asimov (1950) will always be implemented, another group suggested that the failure of the system may occur anyway.

Question 8. How do you imagine people and humanoids living together in the future?

The first group:

Table 9. *Public awareness of the humanoids future role in the human society. The first group.*

Options	Respondents	Respondents (in percent)
People and humanoids will be equal because humanoids will have AI conscious.	10	17,9
Humanoids will do all hard job for humans.	38	67,9
Humanoids will start thinking independently what will lead to the next war.	8	14,3
Total	56	100

The second group:

Table 10. *Public awareness of the humanoids future role in the human society. The second group.*

Options	Respondents	Respondents (in percent)
People and humanoids will be equal because humanoids will have AI conscious.	4	9,8
Humanoids will do all hard job for humans.	30	73,2
Humanoids will start thinking independently what will lead to the next war.	7	17,1
Total	41	100

Albeit the predominant numbers from the both groups, 67,9% and 73,2% consequently, voted of the second option "Humanoids will do all hard job for humans.", the least of them performed strong disagreement about the other options. Only 9,8% of the older group agreed with the possible future equality between humanoids and people, yet 17,1% of them believe that AI robots will start new armed conflict.

Contrariwise, the remaining students claimed that humanoids would rather have AI conscious, 17,9% according to the Table 9, than take any weapon, 14,3% according to the same Table.

Question 9. Do you think that humanoids may influence the world military situation?

The first group:

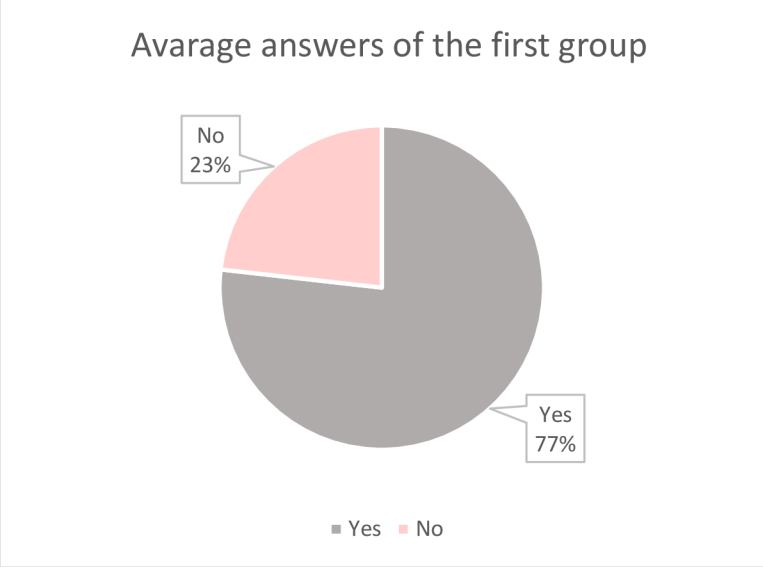

Figure 12. Public awareness of humanoid robots influence of the military situation. The first group.

The second group:

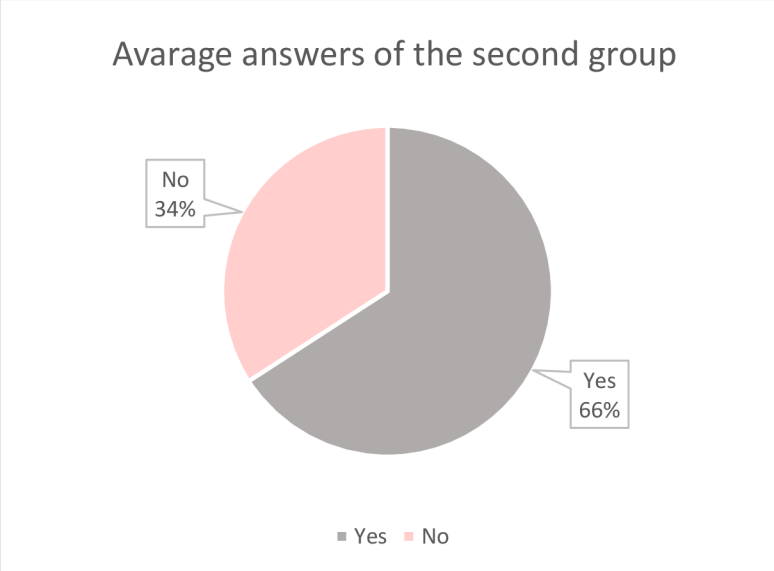

Figure 13. Public awareness of humanoid robots influence of the military situation. The second group.

The results taken from Figure 11 and 12 informed me that the absolute majority of

students (77%) and older audience (66%) think the humanoid robots may take part in armed conflict. However, a lot of people from the both groups (23% and 34%) had the opposite opinion.

Question 10. How the humanoids will influence the world military situation? Start your explanation with "Positively." or "Negatively."

The first group:

I prefer to list positive and negative replies and analyse them shortly, also, there appeared a number of both sides' opinions.

Positive replies:

Respondent 1: *"They can fight more efficiently and do more damage."*

Respondent 2: *"Positively, I think that armies will possibly try to replace or support,"live" forces with androids."*

The main advantages are obvious and clear. According to the respondents, less people will die during the war, what is doubtlessly positive. Humanoids are harder to be damaged in comparison with humans, it means that one humanoid will hypothetically stay "alive" longer than any human, consequently it will destroy more enemies. Thus, it will help the country it belongs to win the war.

A few respondents provided me with **both sides' answers**:

Respondent 3: *"Positively: they will replace all human deaths in the war. Negatively: they will be more lethal."*

Negative replies:

Respondent 4: *"They could do what people say. Without mercy."*

Respondent 5: *"There will be casualties just in steel, therefore people won't hesitate so much in declaring wars."*

The second group:

Positive replies:

Respondent 1: *"Humanoids cannot die."*

Respondent 2: *"We will never regret them."*

Respondent 3: *"They can survive in a lot of conditions where a human will die."*

Those replies are similar to the replies I achieved from the first group. As far as the third replay is concerned, humanoids can survive in horrible conditions like a gas chamber, people will never be able to manage it naturally.

Negative replies:

Respondent 4: *"We do not know which aims they were programmed for! They may kill innocent people! Moreover, they know no mercy!"*

Respondent 5: *"Countries with more advanced technologies will set the pace of the "game". People governing the war one way or another will try to kill other people, not robots what will lead to a lot of casualties."*

Contradictory to the positive replies, the difference in negative replies is slightly more visible. The second group presents more fear concerning the structure code, what is totally explainable. Except this, respondents from the both groups marked the scarcity of mercy. There are a lot of movies, books based on stories from veterans who survived, how mercy saved innocents and even solders lives. The suspicions left by the respondent 5 (the second group) may occur as a collapse of the most visible advantage of humanoid robots usage for military purposes. If humanoid will be used against humans by other humans that would be not hard to predict which side will stay alive.

Question 11. Would you appreciate living together with robots like Sophia?

The first group:

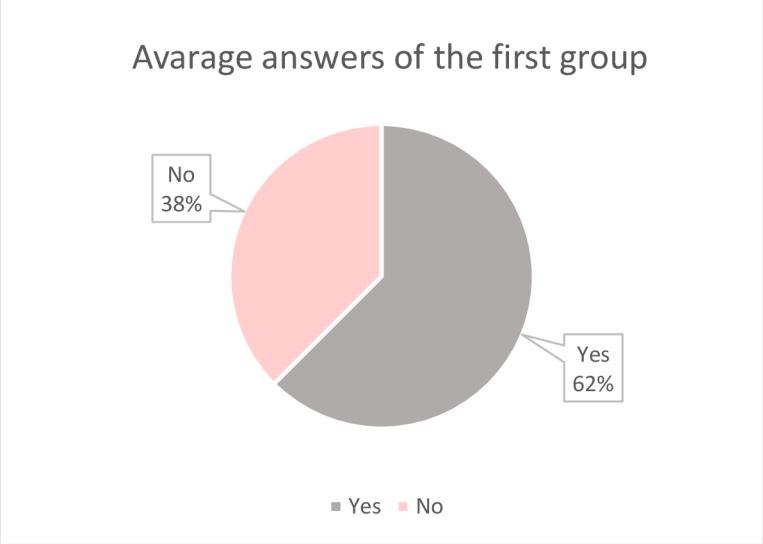

Figure 14. Public opinion on living together with an anthropomorphic humanoid. The first group.

The second group:

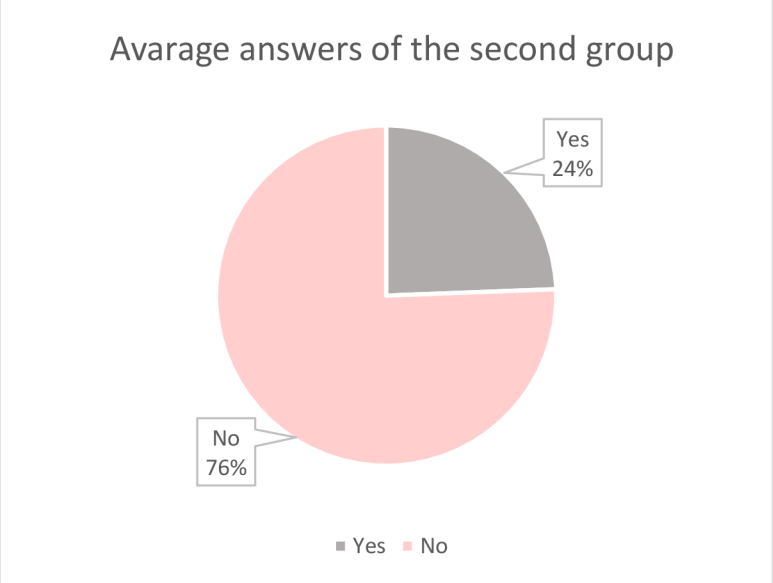

Figure 15. Public opinion on living together with an anthropomorphic humanoid. The second group.

The majorities of the both groups do not appreciate each other's dominant opinion, regarding the results from Figures 14 and 15. The negative attitude to the hypothetical chance to live together with robot like Sophia was expected from the second group, regarding their extended replies for the Question 7.

However, surprisingly high 38% of the first group respondents also pressed "No.". In order to discover the reasons of the expressed level of anxiety the next open-ended question was conducted.

Question 12. Why would not you appreciate living together with robot like Sophia?

As this is an open-ended question, most of the respondent left their opinion, either positive or negative.

First group:

Here it is necessary to mention that the half of the respondents refrained from answering this question. According the formulation of the question, they automatically agreed on appreciating living with sampled humanoid. As far as the rest is concerned, 18 students left answers like either *"I am ok with it, but why? Are not there enough people?"* or *"I would. It is interesting, different life style"*.

However, the reminding 10 people left the negative sentences similar to the one listed below.

Respondent 1: *"Because she is unnatural and creepy! I like to have people with feelings around me"*

Second group:

The completely opposite to the previous group attitude I summarized here, was predictable. According to the percentage from Figure 15, 76% expressed their strongly negative opinion considering humanoid robots living with people.

Respondent 1:*"Because they are not humans. I am a human and I need to live with humans."*

Only few of them, 24% regarding Figure 15, appreciated the discoursing opportunity of living nearby. Even that minority preferred to provide me with rather short than expected

long replies.

Respondent 2: *"I will appreciate."*

Question 13. Would you appreciate the usage of a humanoid like the Bionic Handling Assistant in your everyday life?

The first group:

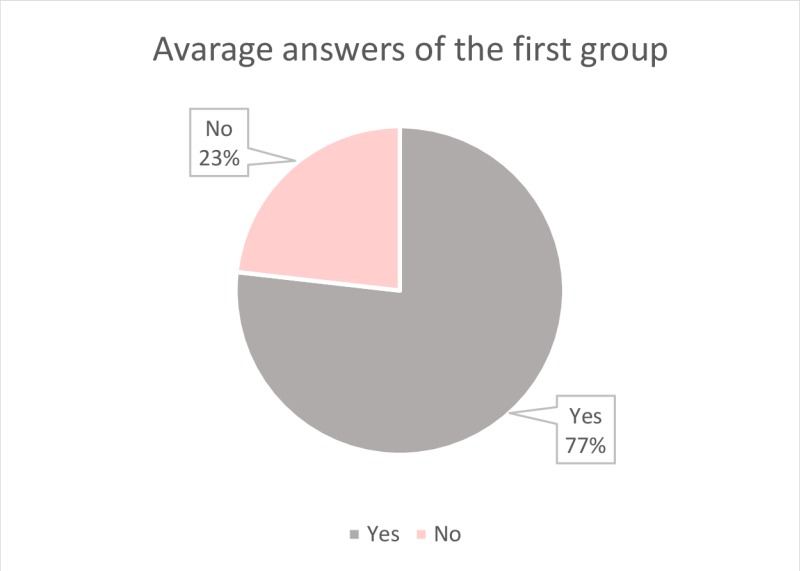

Figure 16. Public opinion on usage of a humanoid like the BHA. The first group.

The second group:

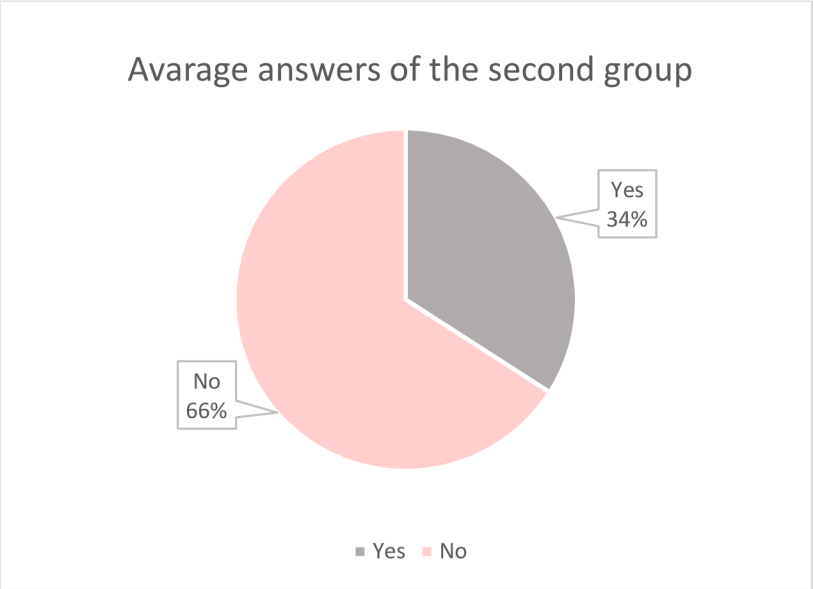

Figure 17. Public opinion on usage of a humanoid line the BHA. The second group.

Results from Figures 16 and 17 provide me with a significant disagreement between two groups. Hence, I created the next open-ended question to identify the reasons of the appeared controversy deeper.

Question 14. Why would not you appreciate usage the Bionic Handling Assistant?

The first group:

Even if 77% of respondents choose option *"No"* as a replay to the Question 13, most of the whole group formulated their answers as:

Respondent 1: *"It is useful for disabled people. Fortunately, I do not need it now."*

The second group:

Respondent 1: *"Healthy people do not need it, they are too lazy even without it!"*

Albeit both of the diagrams from the previous question provided me with a difference in preferences of two investigated groups, this question performed similarities in the reasons.

9 Discussion of research findings

The online questionnaire provided me with the audience attitude to the humanoid robots and their integration into the human live. The most important results I achieved from the open-ended questions. The discussion of the left replies appeals crucial, thus this chapter is added.

Even if the majority of both groups stated for no fear of humanoids, their replies to the open-ended question revealed some uncertainties. As far as the first group is concerned, respondents claimed that humanoids will always follow the instruction from the creator, but it is not possible to be sure about their design. Consequently, the structure of the code appeals disputable, it could be attributed to the influence of the human factor. The adequately educated respondents do not trust enough specialists programming those robots, based on their replies. It is not reasonable to be one hundred percent sure about what was written into the code of any humanoid robot by anyone else. While the majority of the second group connected their fears with the possible losing control over the robots.

Till now the humanity has seen no incident which could have led to human casualties, hence we still have nothing horrible to accuse any humanoid of; however, we cannot predict what may happen in future.

The next discussable topic arise from questions devoted to hypothetical opportunity of living nearby humanoids. Surveyed students expressed enthusiasm, but also claimed that it definitely will not happen in the near future. The other group provided me with strongly negative attitude what can be easily explained – older people are usually more conservative and less willing to integrate anything significantly new in their ordinary live.

10 Conclusion

The main goal of this bachelor thesis was to investigate deeply people attitude to humanoid robots' intervention into their everyday life. Also, it was important to gather the public opinion regarding their possible future life together with humanoids. In order to implement all of the listed tasks the questionnaire was conducted.

I asked two different groups of people – students from VUT Brno University and 35 above years old people with different occupations. The data achieved was analysed and compared after. There were found either differences or similarities, both of them were explained.

Adequately educated young people expressed more positive attitude to humanoid robots in all questions they were asked. Those fears concerning humanoids were explained more scientifically, in the contrary to the other group. For instance, in the both groups the fear of the failure of the system was revealed. The first group explained that a humanoid will follow the program laid on it in each case, thus the problem will be in the design, while the second group interpreted it as *"they will become uncontrollable."*

The historical background as well as modulation were alalysed in the theoretical part of the thesis all goals and sub-goals were implemented with the help of the questionnaire survey.

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14 Appendix

Appendix: Questionnaire

I conducted a research in order to gather and analyse data connected with peoples' attitude to humanoid robots. In order to receive more information in a short period of time, I decided ti create this questionnaire. I will use your replies to implement the posed goals of my Bachelor's thesis. No personal data will be presented here. Thank you for your help.

Alexandra Kovyrcheva

List of questions:

1) What is your occupation?
2) What is your age category?
   a- 18-26 years old.
   b- 27-35 years old.
   c- Above 35 years old.
3) Do you know any of listed examples of humanoid robot? Mark each you know.
   a) WABOT-1
   b) WABOT-2
   c) The BHA
   d) Sophia
4) Do you think that one day in the future humanoid robots will be able to implement all (or almost all) humans work?
   a) Yes.
   b) No.
   c) Yes, but not all.

5) Are you afraid of humanoids?

6) Do you think that people should be afraid of humanoids? If yes, please give the reasons why.

7) Do you think that humanoids will start to think independently from their creators (people)? Give the reasons why.

8) How do you imagine people and humanoids living together in the future?

   a) People and humanoids will have equal because humanoids will have an AI conscious.

   b) Humanoids will do all hard job for humans.

   c) Humanoids will start thinking independently what will lead to the next war.

9) Do you think that humanoids will influence the world military situation?

   a) Yes.

   b) No.

10) How the humanoids will influence the world military situation? Start your explanation with “Positively.” or “Negatively.”

11) Would you appreciate living together with robots like Sophia?

   a) Yes.

   b) No.

12) Why would not you appreciate living together with robot like Sophia?

13) Would you appreciate the usage of a humanoid like the Bionic Handling Assistant in your everyday life?

a) Yes.

b) No.

14) Why would not you appreciate usage the Bionic Handling Assistant?